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ABSTRACT

This guide is intended to assist adult educators in designing and adapting curricula to conform to technological changes in the workplace and to meet the learning needs of adults. The first part deals with the changing workplace and its effect on postsecondary education and with developing programs that respond to change (responses to technological change, strategies for identifying emerging skills, and steps for creating successful high-technology programs). The second part consists of six chapters that detail the following stages in the curriculum development process: assessing needs (assessing business, industry, labor, program, and staff development needs), defining objectives (using information to define needs and goals and establishing priorities), identifying resources (information resources for vocational-technical education and small group techniques for gathering information), developing curricular content (occupational analysis, the Developing a Curriculum Process [DACUM] approach, and the use of adult development information in curriculum development), implementing a curriculum (planning, overcoming resistance, and updating teacher skills), and monitoring and evaluating implementation (developing an evaluation system). Appendixes include descriptions of exemplary high-technology programs and curriculum guidelines and specifications for computer-assisted design, computer-assisted manufacturing, and robotics programs. (MN)

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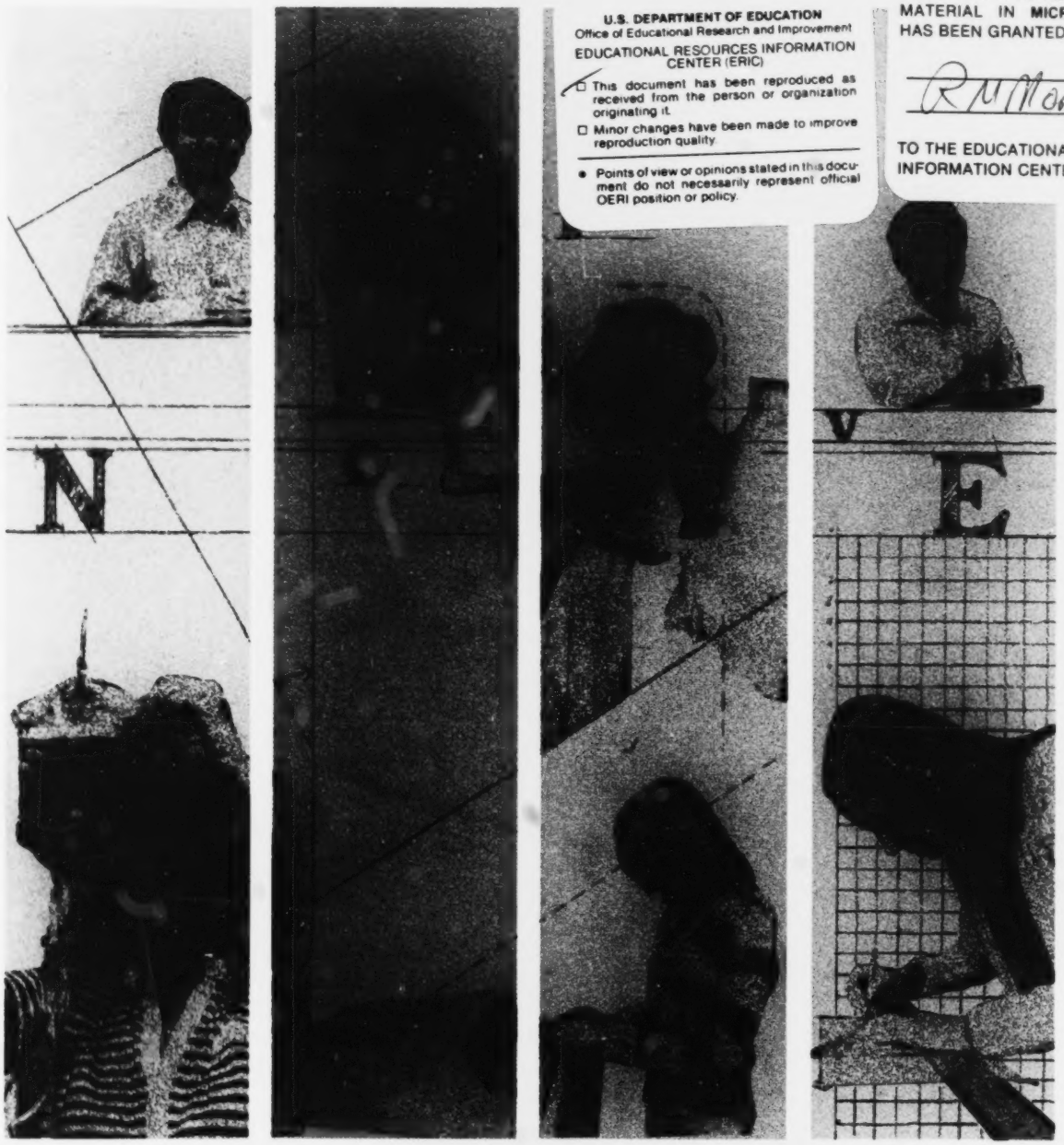

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DEVELOPING CURRICULUM IN RESPONSE TO CHANGE

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FOREWORD

Postsecondary education faces major challenges for the future if it is going to remain responsive to changes in the areas of demography, labor force, economy, and societal expectations. If postsecondary education is to remain relevant, new programs to meet changing technological needs must be developed; increased sensitivity to the changing age, sex, and ethnic composition of the student population must be demonstrated; more training designed for part-time participants and for disadvantaged groups must be offered; and increased cooperation between business and educational institutions must be achieved.

In order to provide postsecondary administrators, program planners, curriculum developers, counselors, and instructors with up-to-date, reliable information, the National Center has developed a packaged set of materials entitled *OPTIONS: Expanding Educational Services for Adults.* This package is the result of a major review and synthesis of the premiere appropriate materials available. Organized around three highly targeted issues, the *OPTIONS* package contains an educator's guide, a videotape, three books, and three monographs.

The *Educator's Guide* orients administrators, instructors, and counselors to *OPTIONS*--its background, philosophy, components, structure, and use. An accompanying videotape discusses the issues and forces impacting on educational institutions serving adults and motivates postsecondary personnel to work for program success.

Linking with Employers provides a rationale for cooperative efforts with business and industry. This book describes procedures for establishing linkages and conducting programs such as co-op education, customized training, retraining and upgrading, apprenticeship, resource sharing, and economic development.

This publication, *Developing Curriculum in Response to Change,* prepares program staff to design and adapt curricula to conform to technological changes in the workplace and to meet the learning needs of adults. This book discusses the six-stage process of curriculum development: assessing needs, defining objectives, identifying resources, developing curriculum content, implementing the curriculum, and monitoring and evaluating implementation.

The three monographs enable counselors and instructors to establish and conduct special services to meet the learning and career needs of adult populations. *Adult Career Guidance* prepares counselors to provide intake, assessment, employability skill development, and career guidance to multicultural, handicapped, and older adults, as well as dislocated workers and women reentering the work force. *Entrepreneurship Education* provides models for planning and implementing an entrepreneurship education program for adults. *Literacy Enhancement* for Adults provides models for planning and implementing adult literacy programs.

Case Studies of Programs Serving Adults describes exemplary practices and programs that have successfully improved or expanded educational services for adults. This book integrates the three major foci of linking with employers, developing curriculum in response to change, and providing special services for adults.

The National Center wishes to acknowledge the leadership provided to this effort by Dr. Robert E. Taylor, recently retired Executive Director. Appreciation also is extended to the following individuals who served as a panel of experts in assisting staff in planning strategy, recommending document content, and critically reviewing drafts of the documents: Dr. Larry Hackney, Associate Dean of Counseling and Life Career Development, Macomb Community College; Dr. Ronald M. Hutkin, Vice President of Academic Affairs, North Dakota State School of Science; Dr. H. James Owen, President, Tri-Cities State Technical Institute; and Dr. Roger Perry, Vice President of Academic Affairs, Champlain College.

Special recognition is due to Judith A. Samuelson, Roxi A. Liming, and Catharine P. Warmbrod who prepared this publication. Recognition and appreciation are deserved by the following National Center staff who played major individual roles in the development of the *OPTIONS* package: Richard J. Miguel, Associate Director for Applied Research and Development, and Catharine P. Warmbrod, Research Specialist 2 and Project Director, for leadership and direction of the project; Judith A. Samuelson, Research Specialist 2; James O. Belcher, Program Associate; Roxi A. Liming, Program Assistant; and David J. Kalamas, Graduate Research Associate, for synthesizing and developing the documents; and Monyeene Elliott, for her word processing expertise and dedication to a major typing endeavor. Appreciation is extended to Judy Balogh and her staff for providing final editorial review of the documents.

Chester K. Hansen
Acting Executive Director
The National Center for Research
in Vocational Education

EXECUTIVE SUMMARY

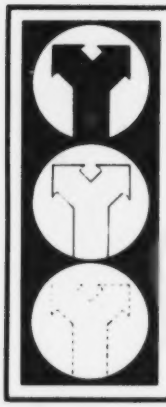
Virtually every indicator suggests that the remaining years of the 20th century will be a period of rapid change. Efforts to increase the competiveness of American products in international markets and the widespread application of computers in production processes and communications should result in unprecedented rates of technological change. These changes will affect the skills needed in the labor force and the training that should be provided for these skills.

Society will also have to adjust to the aging of the population and to reduced numbers of entry-level workers. Vocational-technical educators must respond to these developments. Curriculum changes will be needed to adjust for the new technology, a changing student population, and more part-time students.

Changes in demography, the labor force, the economy, societal expectations, and education itself all impact upon vocational technical education. In order to design and/or adapt curricula that meets the changing needs of the workplace and of adults, program planners and curriculum developers must understand how the workplace is changing, the effects of changes on vocational-technical education, and how educational institutions can respond to these changes.

Program planners and curriculum developers also must understand the program planning process. They must determine how and when the educational institution will respond to the change. They must identify emerging skills and then develop programs that provide adequate training in those skill areas.

The actual curriculum development process involves six stages. The first stage, assessing needs, involves assessing business, industry, and labor needs, program needs, and staff development needs. The second stage, defining objectives, includes defining program growth and quality needs and goals and establishing priorities. Stage three, identifying resources, includes utilizing outside systems, networks, and products and also obtaining information from current staff. Developing curricular content, the fourth stage, involves conducting an occupational (task) analysis, verifying the analysis, analyzing the competencies, translating the competencies to performance objectives, and sequencing the objectives. At this stage, the needs of adult learners also must be taken into consideration. Stage five, implementing the curriculum includes planning for implementation and developing strategies for overcoming resistance to the curricular changes. Monitoring and evaluating implementation, the sixth and final stage, is an ongoing process. This involves developing and implementing an evaluation system to ensure that the program improvement process has been successful.



Introduction

The Challenge to Postsecondary Education

Dramatic technological changes are affecting every segment of society. Word processing equipment is replacing typewriters, CAD stations are supplementing drafting tables, robots are welding automobile frames, and manufacturing tools are being controlled by computerized numerical processing.

Rapid shifts in work force requirements also are occurring. Dislocation among today's industrial workers will continue to increase the numbers of these workers who become candidates for retraining. Many workers formerly employed in traditional "smokestack" industries do not have the skills to compete in the emerging high-technology occupational areas. Programmable, automated manufacturing technologies have taken their former jobs and presented them with new jobs that they are not prepared to handle. Their manipulative skills are no longer needed, and, instead, mental skills in planning, scheduling, and progamming are required.

Information technologies are creating a similar change in the automated office. Higher-level literacy is required for most workers in this sector, and here too, job titles change as workers' jobs are restructured. Technological changes also are forcing changes in management, whether in the office, the plant, or in long-distance operations of the telephone company.

When the content of jobs changed slowly, little need existed for retraining workers. As a result of technological changes, the content of jobs has been modified tremendously. It is estimated that today's young worker may need to be retrained eight or nine times before retiring. Vocational-technical institutions face a continuing challenge to produce workers who can manage, operate, manufacture, test, design, program, install, maintain, and repair new products and processes.

Developing technical-level training programs for new technologies requires that planners, administrators, counselors, and instructors rethink their traditional strategies for initiating and updating programs. Technician training in advanced technologies (such as computer applications, robotics, and lasers) requires sophisticated and costly equipment, continually updated curricula, and instructors qualified on both the knowledge and experience levels in the latest technological developments and equipment. Vocational-technical institutions face serious problems in finding or developing state-of-the-art curricula. Recruiting qualified instructors is equally difficult. Further complicating the situation is the fact that improvements in equipment and processes occur at a rapid pace, resulting in frequent obsolescence of equipment and skills. These, in turn, create new occupations and a demand for new skills.

If vocational-technical education is to remain relevant, educational institutions must be responsive to changes in technology used by business and industry.

Processes for monitoring new and emerging skills must be refined. The procedures for modifying existing programs and developing new ones must be streamlined and made more efficient. Staff must be encouraged to keep their knowledge and skill levels up to date.

Over the years, much information has been written about (1) the effects of high technology on the workplace, (2) the learning needs of adults, and (3) the various aspects of the curriculum development process. This book integrates these three topic areas into one publication. Strategies that educators of adults can use to design and adapt curricula that meet the changing needs of the workplace and of adults are presented. This synthesis of information has been obtained from 21 different publications and provides a comprehensive overview of the curriculum development in response to change process.

This book is intended to provide vocational-technical educators with an awareness of the magnitude of this challenge, to stimulate interest among them in developing and revising programs to meet the challenge, and to provide them with information on how to develop programs and curricula that are responsive to the needs of students as well as business and industry.

How This Book Is Organized

The information in this publication has been excerpted and adapted from previously published materials and represents the contributions of 35 different authors. The original published materials were written for a variety of purposes and audiences, therefore, some revisions were necessary in order to make the information appropriate for this publication. These revisions include reorganizing the information, reformatting the information, and deleting irrelevant or unnecessary information.

Throughout the text, references have been cited where appropriate. For the readers convenience, the complete reference citation is located at the end of the chapter.

The reader is encouraged to refer to the original source material for a more thorough discussion of each topical area. To help in this endeavor, the page numbers that each section has been adapted from are included in the reference note at the beginning of each excerpt. A complete listing of these references can be found in the Source Documents list at the end of this publication.

This book has been divided into two parts. Part I, "The Challenge of Change," discusses the changing workplace, its effects on vocational-technical education, and how educational institutions can respond to these changes. Part II, "Stages of Curriculum Development," describes six stages involved in the curriculum development process.

Part I

Chapter 1 discusses how technology is altering the economy and social institutions. The effects that telecommunications, computer applications, and advanced manufacturing technologies have on labor demand and on occupations are reviewed. The future of vocational-technical education also is explored.

Chapter 2 analyzes three modes that a vocational-technical institution can use to respond to technological innovations. These modes are the "early," "fast-follow," and "delayed" response modes. Strategies and processes used to identify emerging skills and the strategic long-range planning process also are discussed in chapter 2.

Part II

The curriculum development model, as discussed in Part II, entails six distinct stages. These stages are as follows:

1. Assessing needs
2. Defining objectives
3. Identifying resources
4. Developing curricular content
5. Implementing a curriculum
6. Monitoring and evaluating implementation

Accurate appraisal of employer, curricular, and staff development needs is the first stage in the curriculum development process and is discussed in chapter 3. A systematic approach to the process of reviewing employer and employee needs is outlined. In addition, this chapter discusses how a needs assessment can determine the difference between existing and desired levels of attainment in a program area. The process and tasks involved in keeping teachers up-to-date are reviewed in this chapter.

Defining objectives is the second stage in the curriculum development process. Chapter 4 describes how information can be used to establish needs, goals, and objectives. Two methods for establishing priorities, the fatal flaw analysis method and the feature analysis method, are described.

Chapter 5 contains information on identifying resources. A variety of information sources, their location, and their use are detailed. In addition, chapter 5 discusses three small group techniques for gathering information. The techniques discussed are the nominal group technique, the brainstorming process, and force field analysis.

The fourth stage, developing curricular content, is presented in chapter 6. A curriculum development model and the steps involved are outlined. The DACUM process and how it can be used in occupational analysis and curriculum development is discussed. Chapter 6 also contains information about adult development theory and its implications for program development and instruction. Some practical guidelines for promoting adult student retention are given.

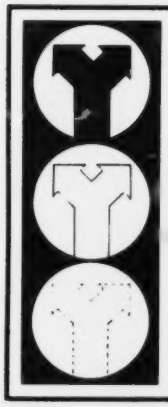
Implementing the curriculum is the fifth stage and is discussed in chapter 7. The planning process for implementation is outlined. Strategies for overcoming resistance to new programs or curriculum are described and six strategies for updating teacher skills are analyzed.

Chapter 8 describes the monitoring and evaluation stage. A description of program evaluation and how it is accomplished is presented. In addition, chapter 8 also contains an outline for developing an evaluation system.

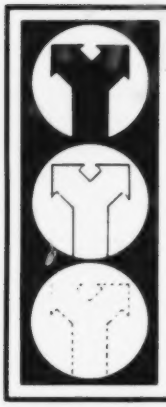
Appendices

An excellent approach to updating or developing curricula for programs is to build on the experience and expertise of others. Appendices A-D present program descriptions that can be used for this purpose.

Appendix A describes 16 exemplary high-technology programs operated by community colleges and technical institutes. Appendix B contains curriculum guidelines and specifications for a CAD program. Guidelines and specifications for a CAM program are outlined in appendix C and appendix D contains guidelines and specifications for a robotics program.



Part I
The Challenge of Change



Chapter 1
The Changing Workplace and Its Effect on Postsecondary Education

The Changing Technological World*

Change is an inevitable fact of modern society, but what is unpredictable is the rate and direction of that change. The world is presently undergoing significant transformations brought about by rapidly advancing technological development. No segment of our society remains untouched by its influence. Technological and economic changes have far-reaching impact on the workplace, the work force, and on education. Permanent worker displacement, temporary unemployment, and needed preparation for future occupations place new and demanding requirements on general and vocational education.

Just as the agrarian society gave way to an industrial one, so is the industrial era being rapidly replaced by a technological age. What title to bestow on the new era seems to be a matter for discussion. But whether a society is called "technological," "postindustrial," "superindustrial," or "informational" is not as important as the changes being wrought and the ability or inability of our society to cope with them.

Toffler (1980a) stated this in *The Third Wave:*

> A new civilization is emerging in our lives, and blind men everywhere are trying to suppress it. This new civilization brings with it new family styles; changing ways of working, loving, and living; a new economy; new political conflicts; and beyond all this an altered consciousness as well. Pieces of this new civilization exist today. Millions are already attuning their lives to the rhythms of tomorrow. Others, terrified of the future, are engaged in a desperate, futile flight into the past and are trying to restore the dying world that gave them birth. (p. 25)

Despite admonitions by Toffler (1970) in *Future Shock,* Bell (1978) in *The Coming of Post-Industrial Society: A Venture in Social Forecasting,* and others, the United States has remained essentially unprepared for the challenges of this technological age. It appears that only when consciousness is raised by such events as the severe economic recession of the past few years that action is precipitated. As workers are displaced from jobs, American industries lose their customers in international markets, and the country's leadership role in technological innovation begins to erode. Next, the cry comes forth for government, education, and industry to do something about it.

*Excerpted and adapted from *Education and Training for a Technological World* (Lemons 1984, pp. 1-11).

The economic impact from the build-up of foreign technology has been severe. One indication of this change is that Japan exports about $5 billion more in high-technology products to the United States than it imports from us ("U.S. Firms Must Adapt Faster" 1983). Recognition of this shift has given rise to a widespread sense of urgency. As the National Commission on Excellence in Education (1983) stated, "Our Nation is at risk. Our once unchallenged pre-eminence in commerce, industry, science, and technological innovation is being overtaken by competitors throughout the world" (p. 5).

Today this country is facing awesome challenges. Technology is altering all social institutions; jobs and careers are increasingly transitory; the educational system struggles to prepare and maintain an adequate level of general and vocational training for our citizens; uncertainty prevails as to what kind of education is needed for living and working in today's increasingly technological, knowledge-intensive economy.

Just as the extended family of the agrarian era gave way to the nuclear family of the industrial period, so has this family structure deteriorated in turn. Few families in the United States today (only about 3 percent) fit the nuclear model of a working husband, housewife, and two children. In fact, one-fifth of all households are comprised of persons living alone. It appears that the family of the future will not fit a single model, but will provide for various styles according to economic, religious, personal, functional, sexual, or vocational choices (Toffler 1980a).

This change in family styles parallels changes in life-styles. Flexible work hours, the home as an office or work space, nontraditional work roles, shifts from strength-intensive to knowledge-intensive occupations, and problems in transportation are becoming commonplace. As the communications technology continues to develop, opportunities for restructuring patterns of family, community, and social life abound.

There will be 125 million persons in the work force by 1990, according to the U.S. Bureau of Labor Statistics. The typical worker will be older and better educated than today's, and more likely to be female and living in a rural area (National Commission for Employment Policy 1982). The population of the United States will increase at a slower rate, and there will be a decreasing number of young workers entering the work force. The rate at which women enter the work force will also decrease as their numbers approach a maximum level. It is predicted that the labor force will grow in the 1980s at less than half the 1970s' rate.

During the early 1980s tremendous numbers of workers were unemployed, with a national average in excess of 10 percent. Regionally, the unemployment rate was higher, with unemployment in West Virginia, for example, at 17 percent. Among black teenage males, the unemployment rate reached approximately 50 percent. Further, structural changes in the manufacturing industries resulted in the disappearance of approximately 2 million jobs of these unemployed workers. As these industries further automate to become competitive in the world market, the number and type of jobs change. Although new jobs will be created in new sectors of the economy, such as the high-technology industries, not enough will be available to employ the dislocated workers who, by 1990, may number several additional millions (Gottlieb 1983).

Jones, Lauda, and Wright (1982) identify two forces that are altering work: (1) expanding technology and (2) a psychology of entitlement. Expanding technology needs little explanation. The psychology of entitlement relates to workers' belief in and demand for satisfaction from work. Self-fulfillment, achievement, and benefits are among the entitlements sought by workers.

DeVore (1980) traces changes in the concept of work from an agricultural society to an industrial society. Factory work

demanded adjustments from outdoor to indoor work and created the need for specialization and highly differentiated occupations. Biologically derived energy (muscle power) gave way to machines and the use of heat energy. Today, work and values associated with work are changing again. Robots and computerized controls are reducing the need for humans in the production system. Work may need to be redefined to include purposeful activity without pay.

These changes are having a significant impact on emotional and intellectual lives. "Human behavior is also affected by the nature of one's specific association with technology in a given society. Those who work with computers and intricate information systems behave differently and think differently than do people whose roles are related to production or servicing sectors of society" (DeVore 1980, p. 257).

Unemployment and changing concepts of and toward work are two of many indicators of the dramatic shifts in the work force resulting from technological development. Just as there are identifiable geographic, gender, and age shifts in the work force, so there are profound changes resulting from new industries and new processes. New forms of automation are having severe worker dislocation effects, especially as traditional "smokestack" industries make changes in their production methods or shut down operations. Many workers formerly employed in these industries are without employment and the skills to compete in emerging high-technology fields (National Commission for Employment Policy 1982).

Already there have been major changes in white-collar and blue-collar occupations. In 1950, 36.6 percent of employed persons were blue-collar workers and 43.4 percent were white-collar workers. In 1980, 52.2 percent of all workers were white-collar workers. Farm workers declined from 7.9 percent to 2.8 percent of the work force in the same time period. Now white-collar workers exceed all other workers by 4.4 percent (ibid).

Confused signals are being transmitted about employment opportunities in this rapidly changing technological world. On one hand, technology is causing displacement of workers, and on the other, it is creating new jobs and occupational titles.

The infusion of new technology into the workplace provides for new and creative jobs and, potentially, a more productive society with greater equity among its participants. There is a clamor about the need for more highly educated and trained specialists, but this appears to be true only in limited fields. For example, the American Electronics Association (1983), in its report on technical work force projections in the electronics industries, states that total employment is expected to increase 49 percent in the 5 years from 1983-1987. That is an increase of 8.3 percent per year when compounded annually. The "hot" categories and corresponding percentages of growth include software engineers (115 percent), electronic engineering technologist (107 percent), and computer analysts/programmers (103 percent).

A quick glance around reveals immediately that the mass education approach to the industrial era is no longer working. As societal values have changed, schools are finding that the purposes for which they stood, the curricula they promulgated, and the methods of motivation and instruction they employed are being questioned. This nation's renewed interest in education is resulting in a fresh look at these old approaches.

Much is still to be learned about the cycles and trends of the workplace and work force in a technological world. This unsettled condition causes problems for individuals as well as giving rise to difficulties in establishing educational and training programs to meet the needs of both individuals and employers.

Changes That Influence the Workplace*

In order to understand the effects that the adoption of advanced technologies is having or may have on American industries and workers, three areas of important technological innovation and expansion are reviewed here. The three are telecommunications, computer applications, and advanced manufacturing technologies (including robotics). These areas serve as examples of how changing technologies are affecting business and industries, labor demand, and workers themselves, especially in terms of the demands for training or retraining in technician-level occupations with technology-related skills.

In each of the technology areas reviewed, major examples of kinds of technological innovations and users applying those innovations are reported. The effects the innovations have on labor demand and on occupations are drawn from reviews of literature dealing with labor and technology. Finally, forecasts are reviewed for anticipated effects that the technological innovations will have on job content, skills, and skill levels for workers in technician-level jobs. Each technology area reviewed is briefly summarized.

The overview of changing technologies does not attempt to be definitive. It represents ways that a concerned vocational-technical educator, administrator, or advisory committee could collect vital information on trends in technological change (and its effects on labor and skill demands) by reviewing literature available in journals and documents. Such information, which can be gathered inexpensively and with only moderate time and effort, can be crucial to those involved in planning, developing, and updating programs or curricula in high-technology areas.

The utility of this information for participating in local or regional economic development efforts is also high. By monitoring information on technology changes, with attention to supporting economic, political, and social factors, educators can lessen the probability of encountering unexpected shifts in local training needs. Postsecondary faculty, representing a wide range of interests and expertise, also can be pivotal in heightening the awareness of local employers about technological innovations, the ease or complexity of adopting or adapting them, and the potential of these innovations for boosting productivity. Finally, by maintaining an awareness of emerging technologies and trends in labor/skill demands, postsecondary institution faculty should be better able to anticipate national patterns and use that knowledge to create appropriate high-technology training programs that will attract new industry to the region, help create new jobs, and aid in the entry and advancement of local workers in technician-level jobs in American industry and business.

Telecommunications

The field of telecommunications is one of the most rapidly changing industries in the world. It is driven by innovations in and declining costs of microprocessors, fiber optics, laser beam transmission, computers and computer systems, microwave transmission hardware, coaxial cables, and synchronous-orbital communications satellites.

New Technologies, New Users

The microelectronic revolution is less than a decade old, yet its impact on our society and on the world as a whole has affected the speed, availability, cost, and effectiveness of every kind of communication. It has made information, entertainment, and data manipulation available to government, business, the military, and

*Excerpted and adapted from Preparing for *High Technology: Strategies for Change* (Faddis, Ashley, and Abram 1982, pp. 5-16).

private citizens. Uses of telecommunications are expected to expand by the end of the 1980s, bringing us into an era that futurists are calling "the global village."

Examples of the technologies affecting telecommunications are data networks, satellite and digitally encoded telephone and telecopy devices and systems, optical fibers and cables, electronic mail and shopping services, text editing and distribution systems, and electronic funds-transfer systems. Potential future technology applications, such as inexpensive bubble memories and Josephson junctions, may make telecommunications even faster, more accurate, and able to handle larger bulks of data (National Research Council 1979).

Telecommunications Technologies and Work

The adoption or adaptation of new technologies in an industry affects the industry and its work force in many ways, among which are labor demand (job creation, job obsolescence), occupations (new occupations emerge, old occupations vanish, occupational clusters change due to increasing specialization), and job content and skill requirements. Studies of changes in telecommunications industries and their patterns of employment provide some data for forecasting likely trends in labor demand, occupations, and job content and skill requirements. The focus here is on technician-level jobs--those of importance to 1- or 2-year technical or community colleges.

Changes in Labor Demand

Manufacturers of telecommunications equipment are being dramatically affected by the applications of microchip circuitry. Telecommunications Ericson in Sweden reduced its work force from 15,000 to 10,000 workers between 1975 and 1978, and employment in telecommunications manufacturing in Britain dropped from 88,000 workers to 65,000 during the same period (Norman 1981a). This has been the trend all over the world in that industry.

Installation and maintenance labor can be expected to be similarly affected as advanced technologies continue to be adopted in the telecommunications industry. For example, do-it-yourself telephone installation has already drastically reduced the phone installation force of the Bell System across the United States, and some maintenance functions presently performed by the industry also will be transferred to the customer in the 1980s. Developments such as dedicated plant lines (permanently installed lines and connectors in commercial and residential buildings), buried cable, and quick-connect terminals are reducing labor demand (as well as skill levels) for line and cable workers (Dymmel 1979).

Other telecommunications jobs also will be affected by the new technologies. New switching equipment has affected the number of telephone operators in the past, dropping the percentage of the industry's total employment from more than 50 percent in the mid-1940s to less than 20 percent of the industry's work force today. Advances in artificial intelligence (such as computer verbal/oral discrimination and decision-making capacities) and mechanical voice simulation may continue to depress the demand for human operators.

The potential widespread adoption of electronic postal services, shopping services, and home computer terminals may affect labor demand in the postal system, in newspaper printing and distribution, book publishing, retail and wholesale sales and distribution, and--via electronic funds transfer--banking and financial manipulation. Forecasters concerned with the technology expect that mail carriers, printing tradespersons, distribution and

delivery workers, and bank tellers will experience a decline in labor demand.

According to Orth and Russell (1980), an emerging telecommunications occupational area is that of laser technicians. They stated:

> The capability of fiber optics and lasers to communicate vastly increased amounts of information (as compared with electronic transmission) and fiber optics' resistance to electromagnetic deterioration seem to ensure expanding usage, with consequent increased demand for skilled technicians in those technologies. (pp. 84-86)

Changes in Job Content, Skills, and Skill Levels

In the telephone industry, most technician-level jobs are involved either with switching systems or with signal transmission.

> New electronic switching systems (ESS) require less labor and different skills than older systems. ESS machines are preprogrammed to fit each specific office; therefore, skill requirements are reduced considerably for craftworkers who install these systems. Similarly, less maintenance is required because ESS monitors its own performance and diagnoses circuitry problems. ESS also is changing skill requirements. The system has no moving parts, thereby eliminating the need for mechanical repair skills. However, knowledge of electronic computer-based systems and programming concepts is required. Thus, the technical skills and educational requirements are increasing for ESS-related work. (Dymmel 1979, p. 14)

Changes in transmission systems (including coaxial cable networking and multiplexing) are expected to alter skill requirements significantly for transmission systems craftworkers. The use of fiber optics may reduce skill requirements, because the optical systems involved will be preengineered and the equipment at the ends of the transmissions systems (i.e., equipment in central offices) will remain principally electronic. Central office craftworkers will retain their current approximate skills levels, but "dedicated plant lines, buried cables, and quick-connect terminals are expected to lower skill levels of line and cable workers" (Dymmel 1979, pp. 14-15).

Summary: Telecommunications

Observers of the telecommunications field seem to agree that labor demands in general are decreasing and will continue to do so, with telecommunications manufacturing workers, installation and maintenance labor, and possibly telephone operators suffering the most job decreases. Potential areas of growth are cable television technicians, laser technicians, and ground-based satellite transmission technicians.

Almost every occupation--or job within an occupational cluster--in the telecommunications industries is expected to undergo changes in job *content*, as well as in the skills and levels of skills required. Because of engineering design and the proliferation of computerized monitoring systems, most manufacturing, crafts, and installation jobs will probably require lower skill levels than before, particularly for mechanical skills, although an increase in demand for computer systems and programming skills may raise the skill levels in some of those occupations.

Computer Applications

The advent of microprocessors is as intimately bound to new computer applications as it is to the telecommunications

field, and its impact is equally sweeping. The incorporation of microprocessors together with optical scanners, electrostatic printers, laser-imaged discs for information storage and retrieval, telecommunications equipment, and so forth, is revolutionizing data processing, information storage and retrieval, word processing, automatic accounting and inventory control, publishing, printing, and entertainment.

New Technologies, New Users

Industries directly involved with or affected by the new computer applications include automobile manufacturing, banks, insurance firms, retail and wholesale businesses, computation instrument/calculator manufacturers, newspapers, health care facilities, libraries, and electronic game manufacturers, among others. Probably no industry exists in the United States (or in other industrialized countries) that is not being affected by new or emerging computer applications. Even the agriculture and the fishing industries are using computers.

Types of jobs and occupations directly involved in computer-using industries that are currently or are likely to be significantly affected by the new applications include computer operators and programmers, retail salespersons, data-entry technicians, typists and secretaries, insurance claims processors, editors and printers, accounting and inventory workers, installation and maintenance workers, manufacturing workers, and so forth. Few, if any, occupations are left untouched by the new technologies.

Computer Application Technologies and Work: Changes in Labor Demand

Microprocessor applications seem likely to affect clerical workers first and perhaps most strongly. A 1978 report to the president of France projected that by 1990, 30 percent fewer workers would be needed to produce a given volume of work in the insurance and banking industries. Another study forecasted that the introduction of microelectronics into office equipment in Switzerland would entail the loss of some 250,000 office jobs in that country ("Effects of New Technologies" 1980b). A British forecast projected a minimum job loss in excess of 36,000 over 10 years due directly to the proliferation of word processors there, with a possible maximum loss of 260,000 jobs by 1989 ("Effects of New Technologies" 1980a).

Not all employment analysts agree with this grim scenario for office workers. Bradbury and Russell (1980) stated that word processors do not reduce clerical numbers. Instead, they found that word processors gave secretarial type support to managers where previously this had not been available. *Business Education Forum* (1980) also proposes that computerization of offices in the United States will not dramatically affect labor demand for office workers in this decade.

Inroads have also been made by computer technologies on printing and journalism-related industries. Computerized phototypesetter machines are replacing old, mechanical linotype machines. The computerized equipment outperforms the mechanical machines and has already eliminated some jobs while drastically altering the skills required by the operators. Electronic paste-up computers vastly streamline layout work and have reduced the demand for skilled layout artists and changed the skills they require.

The proliferation of mini- and microcomputers in businesses and in homes and the development of information networks for them may open jobs in maintenance and service, as well as in data entry/updating work (except for keypunching, which is becoming an obsolete technology), and other information-handling occupations, such as journalism and editing. These may not be newly created jobs, however, but primarily crossovers from newspapers and so forth.

Changes in Occupations

Technology can create major changes in occupations very quickly. Twenty-five years ago, computers were a minor field, but by 1978 there were 800,000 jobs in the computer industry (Orth and Russell 1980). The occupations of computer programmer, analyst, and operator were simply not open before the mid-1960s. A number of new occupations are emerging as a result of the newer computer technologies, including composing machine operator, word processing specialist, and records management technician.

As computers become vital to more businesses and industries, specialized data-entry-and-retrieval occupations may develop. Specialized data-manipulating occupations may combine with many existing occupations in health care, in the insurance industry, in education, in environmental and consumer protection, and in a multitude of other service industries.

Changes in Job Content, Skills, and Skills Levels

Most observers of emerging computer applications believe that the technology's proliferation will have adverse effects on skill levels. Cherns (1980) pointed out that computerized warehouses reduce or eliminate the skills of storekeeping and the self-supervision of warehouse workers. According to the German Union of Salaried Employees, the 30,000 word processors installed in that country's offices created jobs with high stress components, that resembled work at the assembly line ("Effects of New Technologies" 1980a).

Opposing perceptives do exist. For example, Schramm (1980) suggested that computerizing offices offers opportunities for greater job expansion and satisfaction for clerical workers. Uhlig, Farber, and Bair (1979) also anticipate greater job satisfaction for office workers, resulting from the increased efficiency of some office processes and the elimination of others through office computerization. Some of the professionals' administrative status may be shifted to secretaries, along with lower-level decision and management responsibilities. This could result in secretarial positions (under a different title) becoming entry-level managerial jobs.

Summary: Computer Applications

Declines in labor demand for office workers are forecast, due to proliferation of computerized office equipment (especially of word processors) in the 1980s. This pattern of decline is not anticipated by some American analysts. Some job losses may be expected in printing industries, however. Job gains are predicted for computer programmers, maintenance and service workers, operators, and analysts, as well as for other information-handling occupations (except keypunchers). New specialized data-manipulating occupations that combine in-depth knowledge of a particular area (such as health care) are expected to emerge or expand in many businesses and industries.

Skill requirements in many occupations, especially in office work, may decline somewhat, due to simplification of tasks involving use of computerized equipment. Use of the equipment itself is not expected to require high skill levels. Another perspective suggests that computerization will relieve many workers of disagreeable tasks and will free them for more important ones.

A British report pointed out that there are some other, work-related effects of computerization of offices:

> Although microtechnology will create new jobs, it is extremely unlikely such job creation will be on a matching basis [that is, that new jobs will equal staff reductions]. And, because most jobs involving typing are carried out by women, it is women

> who will be hit the hardest. The problem will be aggravated by the fact that the female labour force is expected to increase both in real terms and as a proportion of the total labour force. ("Effects of New Technologies" 1980a, p. 11)

This report further stated that many of these office jobs are filled by youthful workers, and elimination of substantial numbers of clerical jobs will aggravate the youth unemployment problems of that country--which are not unlike those in the United States.

Computerization of office equipment may hold new opportunities for employment of the handicapped. A report from Switzerland on "talking typewriters" (audiotyping units using synthetic speech, which is a microprocessor application) proposed that the new device will give access to office jobs for the blind or visually handicapped ("Effects of New Technologies" 1980b).

Advanced Manufacturing Technology

Today's advanced manufacturing technologies make use of sophisticated design, fabrication, assembly, finishing, and quality control equipment incorporating microprocessor-driven control systems, lasers, programmable computerized robots, optical scanners, and an enormous array of new materials and processes. Makers of advanced manufacturing equipment (e.g., Cincinnati Milacron, TRW, General Electric. Rockwell International) have devised machines and tools that improve manufacturing accuracy, efficiency, costs, and safety for such users as the automobile industry, the aerospace industry, the construction industry, steel and other materials producers, and mining companies, as well as the home handyperson.

Advanced Manufacturing Technologies and Work: Changes in Labor Demand

The introduction of industrial robots that incorporate microprocessor controls, and the reduction of the number and complexity of parts in assembled products through the introduction of microprocessors in the products themselves, have already had considerable impact on labor demand in the manufacturing industry. In the United States, NCR reduced its American work force from 37,000 workers to 18,000 workers between 1970 and 1975, because its electronic cash registers required only 25 percent of the labor required to produce the company's earlier mechanical or electromechanical models (Norman 1981b). The introduction of robot welders in automobile assembly resulted in a 20 percent boost in productivity, and a 10 percent reduction in the labor force at the General Motors plant in Lordstown, Ohio (Norman 1981b), and this is only one plant in a major industry.

Computer-aided design (CAD) and computer-aided manufacturing (CAM) are revolutionizing manufacturing. CAD not only speeds up the laborious process of drafting, it also enables the designer to simulate various aspects of an object or assemblage by rotating, disassembling, and reassembling it on a computer screen, as well as testing it under a variety of known, simulated conditions. At General Motors' Fisher Body Division in Warren, Michigan, the use of on-screen CAD testing saves enormous expense and time that otherwise would be spent in fabricating prototypes for testing and design modifications.

CAM, computer control of production machines, ranges from machine tools running on punched-tape instructions to robots that can be reprogrammed to perform a variety of

complex industrial tasks. In many tasks, such robots outperform human operators in speed, accuracy, and dependability. When CAD and CAM are linked together, their advantages are magnified. At Pratt and Whitney Aircraft Corporation, turbine blades (as well as other aircraft parts) are manufactured directly from CAD drawings, with the entire production process automated. In many cases, CAD has allowed gains of 5:1 to 6:1 reduction in labor, and at least 2:1 reduction in lead time. These ratios go up to 30:1 and 50:1 when CAD is linked to CAM (Bylinsky 1981). The potential for labor displacement by CAD-CAM systems in other manufacturing industries is clear.

In the textile industry, the pattern is the same. New technology is expected to replace as many as 300,000 textile workers in the United States by 1990. Pattern-cutting robots utilizing computer controls and laser cutting have already reduced skilled labor requirements in a British garment manufacturing plant from 200 employees to only 20 (Bylinsky 1981). Microprocessor-controlled sewing machines may similarly affect the task of clothing construction (Lund 1981).

In agriculture, advanced technology is being incorporated into mechanical harvesters. In 1980, California farmworkers claimed that the introduction of such harvesters for lettuce and wine grapes would replace as many as 40,000 jobs by 1982 ("Effects of New Technologies" 1980b).

The employment picture is not entirely bleak, however. The machine tool industry in the United States has been plagued by skilled labor shortages over the past 10 years. Employment dropped 40 percent, from 111,000 in 1969 to 76,000 in 1974, then stabilized around 80,000. When the auto industry began retooling to meet federal safety and fuel efficiency standards, United States machine tool manufacturers were caught with too little capacity and too few employees to fill the deluge of orders, resulting in back orders of up to 2 years (Adkins 1981). Analysts blame the skill shortages on the machine tool companies' lax attitude toward training skilled labor.

The area of industrial maintenance, which employs mostly skilled workers, is expected to grow in number by 3 million new jobs by 1990 (Sniegoski 1979). In addition, the manufacturing maintenance occupations (involving 34 maintenance-related positions, according to the *Dictionary of Occupational Titles)* are expected to lose half their members during the 1980s due mainly to retirements, as a large portion of those skilled workers are currently older than 50 (Barker 1979).

The pharmaceutical industry exploits automation but does not seem to be suffering significant reductions in levels of employment. What it is experiencing is a change in skill balances with new training needs (Bradbury and Russell 1980).

Changes in Occupations

As noted above, new manufacturing technologies are making a number of occupations obsolete, particularly semiskilled and skilled occupations such as pattern-cutters and sewing machine operators in the textile industry. No evidence was found that specific new occupations will emerge as a result of the new technologies. Existing occupations such as machinists, maintenance/repair workers, and the many other manufacturing technician occupations are likely to change in job content as they incorporate knowledge and skills in such areas as laser operation, robot control, and computer operation.

Changes in Job Content, Skills, and Skill Levels

The new manufacturing technologies seem likely to create the need for new skills and may decentralize decision making to some degree. Most observers think that the new technologies will decrease skill

levels in general and eliminate some skills entirely.

Sniegoski (1979) points out that the designers of machinery are making major efforts to deskill the operation of their machines. Moreover, in *The Machinist Shortage*, Schultz (1980) claimed that large companies have been putting as much work as they can onto computer tapes to be performed by semiautonomous machining centers, and that jobs that cannot be computerized economically are being broken down at the drafting table into steps that can be performed by less skilled machine operators. This shows that a deskilling of manufacturing occupations, through adoption of certain machinery and the redesign of manufacturing processes, is indeed underway. However, it is reasonable to expect, as mentioned earlier, that at least some manufacturing technician jobs will require an expansion of skills in such areas as laser operation, computer programming, and numerical control system maintenance and repair.

Summary: Advanced Manufacturing Technology

The new manufacturing technologies seem likely to affect employment levels, occupations, and job and skill content in all aspects of product manufacture and use. These technologies will dramatically increase productivity, but this will tend to be a "jobless growth," resulting in little actual job creation. Exceptions are likely to be in maintenance and repair jobs, laser technician jobs, and some specialized computer-related jobs.

Those occupations not likely to survive the influx of new technologies may be agricultural harvesters for certain farm produce (such as wine-grape pickers), garment industry workers in pattern-cutting and garment fabrication jobs, and semiskilled laborers (such as riveters, loaders, and so forth) in manufacturing/assembly jobs. In those jobs that will be retained, job content and skill levels seem likely to change, although no general trend is clear. Some jobs will require entirely new skills, and many will require at least an elementary ability to work with computerized control systems. The simplification of production machinery, made possible by the advent of microprocessor control systems, will result in deskilling in some jobs, particularly in fabrication and assembly.

Changes That Influence Postsecondary Education*

In addition to being aware of how technological changes affect business and industry, labor demand, and workers themselves, postsecondary institutions must respond to other changes as well. Changes in demography, the labor force, the economy, and societal expectations all impact on the future of vocational-technical education. The following analysis, based on research completed by the Institute for the Future in Menlo Park, California, reports on changes in the environment that are likely to influence vocational-technical education.

Environmental Changes

A number of changes in the environment are likely to impact on postsecondary education. The changes include changes in demography, the labor force, the economy, societal expectations, and education itself. The following discussion details these changes.

*Excerpted and adapted from *Vocational Education: A Look Into The Future* (Ruff, Shylo, and Russell 1981, pp. 12-19).

Demography

- Between 1977 and 1985 the relative number of young people between the ages of 16 and 24 dropped sharply.
- At the same time, the relative share of the population in several other age categories increased, notably those aged 35 through 44 and those 65 and over.
- The relative number of minorities among the younger age groups is increasing, especially if Hispanics are considered as a minority. The illegal alien population, which will number about 10 million people in the early 1990s, is primarily young and Hispanic.
- The relative number of single-parent families is on the rise. Because of their increase and because of the growing number of households that depend on two wage earners, the number of children with a mother in the labor force will rise to almost 60 percent.

The Labor Force

- Fewer young workers will enter the labor force as the population between the ages of 16 and 24 declines.
- Questions of skill capabilities of young labor force entrants may arise as overall achievement scores decline and as a larger portion of labor force entrants come from disadvantaged population groups.
- Women will make up an increasing proportion of the work force. A larger share of this group will be made up of older women reentering the labor force.
- There will be a further shift toward part-time work as more members of two wage earner households opt for greater job flexibility.

The Economy

- As labor force growth rates decline, business will become more dependent upon effective use of capital. This implies more capital used per employee, better trained employees, and possibly more in-house training.
- Employers will have a harder time recruiting skilled workers and are likely to look at relatively untapped groups for new employees: older persons, women who have been out of the work force, the handicapped, part-time workers, and so forth.
- Increasing inflation implies that the cost of specialized vocational-technical education programs will rise. Specialized vocational-technical education programs that do not tie directly into a particular occupational need may run into economic difficulties.
- Anticipated real growth rates of almost 3 percent a year imply the spread of affluence. The number of households earning over $25,000 in constant dollars will double by the 1990s (most of the increase will be in young, two wage earner households). More money will be available for specialized education.
- Businesses taking advantage of growing affluence may be in a better position to spend money on employee benefits, such as education and retraining.

Societal Expectations

- Given the growing force of fiscal conservatism, less public money will

be available for vocational-technical education. It is likely that total public funds spent on vocational-technical education will rise at a slower rate than the growth in nominal GNP.

- Increased dissatisfaction at work will spur demands for extra benefits. Among these benefits are likely to be tuition aid and retraining programs.

- Employers will become much more flexible. We are likely to see more decentralization of responsibility at the work place, more autonomous work groups, and greater use of flexible working hours.

Education

- College attendance of the traditional student--the 20- to 24-year-old full-time attendee--will fall dramatically between the mid 1980s and mid 1990s. This means that to retain enrollment levels, many colleges will seek to attract older, part-time students.

- Postsecondary education will have a greater concentration of older students in their thirties and forties interested in career or occupational change.

- With decreasing enrollments, postsecondary schools will be even more aggressive in recruiting students that have usually been underrepresented: blacks, Hispanics, residents of aging central cities and rural areas, and older students.

- Some postsecondary schools may find it advantageous to cooperate with local businesses to provide in-house training or to arrange educational contracts.

- Public satisfaction (or dissatisfaction) over the quality of education will be an important consideration in the 1980s and could have a dramatic impact on curriculum and public funding support.

- The armed forces will provide a larger portion of all postsecondary training.

Implications for Vocational Education

In addition to these contextual changes, the Institute for the Future's report entitled "Policy Choices for Vocational Education," identified the following considerations and their implications for addressing the future of vocational-technical education.

High Technology

The economic outlook calls for a substantial increase in investment in the 1980s and an increasing substitution of capital for labor. The decade could well be a boom period for new technologies: new computer applications, wide use of microprocessors, a transformation of office word processing and communications, an expansion of health-care equipment, a whole new field of biotechnology, and so forth. The expansion of high technology will have the effects of upgrading many occupations, raising skill demands in formerly routine jobs or creating new, skilled positions. The implementation of new technologies will create a myriad of opportunities for vocational-technical education programs at all levels, if program directors are sensitive to the pace and scale of shifts in employment opportunities.

Loss of Traditional Students

Postsecondary enrollments of students between the ages of 18 and 24 are likely to

fall--particularly after 1985. This will have an especially large impact on the full-time student populations of noncollegiate, postsecondary schools.

Rise in Importance of New Groups

While the number of traditional, young adult, full-time, vocational-technical education students will decline, there should be a sharp rise in new candidate populations. Most notable among these groups will be young adults who are 35 and older, especially women reentering the labor force, women currently holding part-time jobs, and both men and women seeking to upgrade their skills and make midcareer changes. Of all the vocational-occupational education providers, the 2-year colleges seem best suited to meet the needs of this group. The 2-year colleges have successfully recruited from a wide variety of people in this age group, and word-of-mouth information about course options can spread quickly. In order to survive, the more limited noncollegiate vocational-technical education programs will have to develop aggressive marketing networks to identify potential students in these age groups and to convince them of the benefits of their programs.

The Educationally Disadvantaged

Educationally disadvantaged groups will comprise a larger percentage of vocational education enrollment, especially in publicly sponsored programs (e.g., 2-year colleges, publicly supported postsecondary noncollegiate schools, armed forces, and JTPA). This development implies that complementary programs of remedial basic skills courses will be needed along with regular vocational-occupational skills courses. Special programs must be developed to reach specific groups such as inner-city youth, and Spanish-speaking adults in rural counties. Teacher training and curricula should reflect the changing needs of the students. Still, with skilled labor in relatively short supply (and inadequately prepared youth still in abundance), the societal returns of any effective vocational training of these disadvantaged youths should be very high.

Student Achievement

The trend toward lower achievement levels on standardized written tests for students entering vocational-technical education will have serious consequences for curricula, teaching methods, and program goals over the longer term. However, since the decline in standardized test scores has been slight on a year-by-year basis, no dramatic changes can be expected. Further, if motivation has been a factor in the test score decline, it may be that the older adults who are coming back to school for training related to labor force reentry, or career changes, will be far more motivated than younger students. The schools serving more mature students may find much higher student achievement levels in their programs.

Cultural Differences

A large share of minority students will participate at every level of vocational-technical education. Each minority group--blacks, Asians, Hispanics--will bring its own cultural expectations and perspectives. Adjustments in faculties and administrative personnel will be needed to reflect the relative proportions of the clientele being served.

Financial Problems

Public support for vocational-technical education increased rapidly during the 1970s. The same will probably not be true during the 1980s. The growing spirit of fiscal conservatism spawned by the high inflation rates of the 1970s will probably mean that education budgets will not keep pace with overall growth rates of GNP. The expanding population base among older adults may actually increase the

resource base of 2-year colleges and make them an exception among public programs that face serious budget squeezes. The crimp on public budgets would provide a substantial opportunity for the expansion of private-sector programs.

Strong Future Competitors

Two-year colleges have already proven themselves an especially attractive source of vocational-occupational education for anyone over age 24, especially those seeking part-time training. As the number in this age group grows, 2-year colleges should prosper.

To meet its personnel quotas, the armed forces must recruit a larger portion of the shrinking young adult group. Prime targets will be young adult males who have only a high school diploma. There is a need to integrate the needs and objectives of the armed forces into any comprehensive long-term planning efforts in the field of vocational-technical education.

Finally, businesses are likely to become even stronger forces in vocational-occupational training. Many more companies are likely to be offering their employees opportunities for retraining or upgrading skill levels--particularly as young labor market recruits become harder to find, as longer-term employees show more dissatisfaction with their current jobs, and as sophisticated new technologies offer more efficient ways to accomplish certain tasks. A substantial increase of in-house training programs is expected, which will be in direct competition with other vocational education programs. Concurrently, an increase in tuition aid programs and many more business-vocational school joint enterprises is likely.

Curriculum Developments

Factors implying a need for curriculum adjustments include: new programs for changing technological needs; increased sensitivity to the changing age, sex, and ethnic composition of the vocational education population; more part-time participants; and more training designed for disadvantaged groups. The most important curriculum change may result from the growing cooperation between business and the vocational-technical education establishment.

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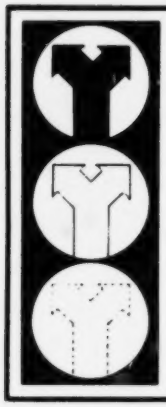

Chapter 2
Developing Programs That Respond to Change

Responding to Technological Change*

As technological innovations move from a developmental stage to an applied stage, their initial use or application by business and industry can pose a dilemma for postsecondary institutions: When should a postsecondary institution initiate a training program to meet the need for new skills and knowledges that emerge as a new technology is used on the job?

A postsecondary institution can choose to respond in one of three modes. The three modes are the "early," "fast-follow," and "delayed" response modes. An institution may employ one or more of these response options at different times and in different situations (see table 1). All three modes may be implemented simultaneously when addressing different technological training needs.

The relative differences of the three response modes are defined as follows:

- *Early response mode.* Institution responds prior to the emergence of a technology in the local region--may establish planning committees with potential users, develop preliminary course plans, initiate inservice training for teachers, and/or conduct seminars, workshops, and conferences to introduce new technology to private sector firms.

- *Fast-follow response mode.* Institution responds soon after new technology is first adopted by local users--may conduct fast-start training sessions, develo[illegible]d conduct core courses, begi[illegible] program development, and e[illegible] offerings as number of users increases.

- *Delayed response mode.* Institution responds after new technology is well established among regional users--courses and programs are developed to meet job opportunities when future growth of the technology is ensured.

The early and fast-follow modes can facilitate the rapid adoption of new high-technology innovations, leading to improved productivity, product quality, and local economic development. A delayed response can also be an appropriate course of action for an institution depending on certain factors that can affect the success of a new program.

*Excerpted and adapted from *Preparing for High Technology: Strategies for Change* (Faddis, Ashley, and Abram 1982, pp. 19-28).

TABLE 1

CHARACTERISTICS OF THREE RESPONSE MODES BY POSTSECONDARY INSTITUTIONS TO HIGH TECHNOLOGY

Response Mode Characteristics	Postsecondary Response Modes		
	Early	Fast-Follow	Delayed
Enrollment	Speculative	Variable	Stable
Technology Transfer	Initiates	Initiates and supports	Supports
Industry Expansion	Attracts expanding industry	Supports expanding industry	Maintains extant industry
Program Changes	Frequent	Regular	Occasional
Availability of Curriculum	Little or none	May be available but not widespread	More readily available
Availability of Qualified Instructors	Few or none	Limited	More readily available
Employment Demand	Limited	Expanding	Steady, depending on the economy
Availability of Cooperative Position	Limited	Expanding	Steady, depending on the economy

Factors to Consider

A number of factors can affect the timeliness, effectiveness, and long-term success of postsecondary programs developed under the early and fast-follow response modes. Findings from site visits, discussions with educators and employers, and reviews of other research suggest that there are at least three factors:

- *The nature and adoption rate of a technology* in local or regional business and industry sectors
- *The level of planning, cooperation, and resource sharing* among government agencies, educational institutions, and business and industry groups
- *The existence of flexible institutional capabilities* essential to the rapid development, delivery, and maintenance of courses and programs in high-technology fields

The Nature and Adoption Rate of Technology

Since there are many variables in the adoption and diffusion of technological innovations, educational planners should assess the potential impact of technological changes on the education and training requirements of occupations. The selection and timing of program responses to technological changes should be made on the basis of such an assessment to ensure that the

most appropriate response is chosen. Additionally, the assessment can help to ensure that sufficient time, resources, job opportunities, and student interest are available to support new program initiatives.

When assessing the nature and potential adoption of a particular technological innovation, attention should be given to its probable impact on a local region. The following are examples of questions to be answered in such an assessment:

- Is the technology generic (applicable to many users' needs; e.g., minicomputers) or highly specific (useful to a limited group of users; e.g., laser welding)?
- Are larger organizations likely to be the early adopters or will smaller firms adopt first?
- How rapidly is the innovation being adopted in other regions?
- Is the relative cost of the innovation high or low?
- Are local conditions (labor costs, type of industry, age of existing technology) favorable to rapid adoption in the near future?
- Will the adoption of a new product or process increase or decrease the amount of training required of workers and technicians?
- Will the adoption tend to increase or decrease job opportunities in the local region?

Planning, Cooperation, and Resource Sharing

A second factor that can greatly affect the early and fast-follow development and maintenance of high-technology programs in postsecondary institutions is the level of planning, cooperation, and resource sharing among government agencies, postsecondary institutions, and the business and industry community. The need for advance planning and cooperation among these groups in developing high-technology programs is essential in light of the high costs and related risks frequently involved in starting such programs. Joint planning, close cooperation, and extensive support and resource sharing between postsecondary programs and the private sector often is associated with the existence of high-technology development groups, expanded advisory committee functions, and the involvement of leading high-technology corporations.

Many questions can be asked in assessing the local potential for advance planning, cooperation, and resource sharing. Some sample questions are as follows:

- What is the technological profile of existing local businesses and industries?
- Which local companies are manufacturers and which ones are users of high technology?
- Do business and industry groups already exist that might be willing to join in forming a high-technology council?
- What linkages exist between the postsecondary institutions and the private sector that can be strengthened?
- What agencies at the state government level could play a role in establishing access to and dialogue with major corporations?
- Are there local business, industry, or civic leaders who are willing and capable of initiating cooperative planning efforts in and outside the local area?
- Can private sector firms provide needed resources and facilities?

- Are firms willing to and capable of providing work stations as part of a high-technology cooperative education program?

- To what extent will local and regional companies participate in advance planning activities regarding future trends in technology adoption, emerging training needs, and commitments of resources and support for new programs?

Institutional Flexibility and Response Capabilities

A third factor that can affect postsecondary program responsiveness in the early and fast-follow modes is the flexibility of the institution and its capacity for rapid response to emerging needs. Flexibility refers to the institution's capacity to initiate and carry out a broad range of activities without unnecessary bureaucratic restrictions and delays. Rapid response refers to the capacity of the institution or its various program areas to determine quickly the training needs of specific firms, develop new courses, quickly deliver instruction through a variety of techniques, and/or access technically competent individuals to serve as instructors.

When assessing an institution's capacity for flexible and rapid response, several specific capabilities should be examined. The following questions can serve as guides to the assessment process:

- Is there a quick mechanism for contracting directly with employers to develop and deliver special training programs?

- Are faculty allowed to provide consulting and coordinating services to aid a business or industry in solving either technical or personnel training problems?

- Can multiple tracks or course options within a program be made available to accommodate the training needs of workers from different firms or with different levels of education and work experience?

- Is there an existing procedure that allows the institution to collaborate on providing special seminars, workshops, or conferences with a focus on new technology and issues of special interest to local business and industry?

- Does or can the institution involve local chapters of business and industry associations and professional and trade groups in planning and developing new courses or programs?

- Will the state governance agencies develop alternative policies to facilitate more rapid program approval and special funding for early or fast-follow responses at the institution?

- What previous activities or experiences has the institution conducted that could be highlighted to demonstrate its capacities to business and industry?

- What programs and faculty competencies are in the institution that can serve as a foundation on which new programs or training activities can be built?

There are other questions that can be raised in assessing an institution's current and potential capacities to respond quickly and in a flexible manner to emerging high-technology training needs. The concern here is that institutional capacity is one of the important factors related to successful efforts to plan, develop, and deliver the needed training in emerging high-technology businesses and industries.

Strategies for Responding

After assessment has been made regarding (1) the impact of a technology on the local setting, (2) the potential for planning, cooperation, and resource sharing, and (3) the capability of the institution to respond, a decision can then be made as to which response mode to select.

Early Response Mode

If the results of the assessment support the need for an early response, the following strategies may be implemented as part of the response:

- Obtain advance information and advice from R&D labs in industry and from universities that are involved in high-technology research projects. Because these sources can provide information about emerging technologies and innovations, programs can be planned that will be relevant when the new technologies come on-line.

- Upgrade instructional staff via cooperative arrangements with high-technology companies and universities, whereby instructors spend time gaining experience with the newest equipment and processes by working in those environments.

- Recruit new instructors with recent engineering backgrounds to aid in upgrading and guiding those with more traditional backgrounds.

- Form or join an alliance with other educational institutions for the purposes of sharing the costs of developing new programs and courses in high-technology areas, sharing materials and ideas, exchanging faculty for teaching and inservice activities, identifying and sharing combined expertise and resources with businesses and industries, and mutually supporting projects in areas of common needs.

- Establish or strengthen linkages between postsecondary technical colleges and universities to utilize the university's facilities and faculty expertise, and aid in curriculum development.

- Seek funding (especially "front money" to develop new programs) from sources such as state economic development agencies, industrial associations, or foundations. Funding from these sources permits programs to be developed and implemented more quickly than by usual funding methods, which may require certain enrollment or job demand levels for program approval.

- Gain access to highly specific and expensive equipment through cooperation with related industries, or compensate for the lack of equipment by the use of innovative instructional approaches (e.g., using video simulation).

- Develop a few initial or supplemental courses in specific high-technology areas (e.g., computer graphics) to meet more immediate needs. These courses can later be expanded to create more comprehensive programs to meet long-term needs as the technology becomes more widely adopted.

Fast-Follow Response Mode

If the results of the assessment suggest the fast-follow mode as the most appropriate course of action, the following strategies may be employed:

- Establish a panel of experts in the technology area to aid in rapid development of training courses.

- Secure technical information and materials from manufacturers of the technical products and devices to be used in training sessions.

- Seek out technically competent business or industry personnel as part-time instructors in new training courses.
- Develop a few "core courses" or supplemental units of technical instruction to meet immediate needs.
- Adapt training courses or course modules from companies that have already developed them.
- Update the knowledge and skills of key faculty members through intensive training courses available through leading industries.
- Use facilities or equipment that may be available in the private sector or local universities.
- Use cooperative training experiences to provide students with exposure to the latest generation of equipment and processes.

These strategies are specific actions that, ideally, should facilitate successful program development and operation. The ideas offered are intended to stimulate the thinking of educators and business and industry personnel toward increased joint planning, cooperation, and resource sharing to meet the current and future needs for trained technicians in high-technology occupations.

Strategies for Identifying Emerging Skills*

The rapid rate of technological change has created significant problems for vocational-technical education curriculum development. It is difficult to keep the content of vocational-technical education programs current with the needs of business and industry. Because the process required to develop or modify curricula is lengthy, curricula may be partially obsolete by the time they are approved and put into practice.

It is apparent that vocational-technical education must become more responsive to changes in technology in business and industry if it is to remain relevant. Processes for monitoring new and emerging skills must be refined. A variety of curriculum development projects, research reports, and journal articles reveal strategies and processes that are being used to identify emerging skills. Some of these techniques are described below along with examples of their applications. Exhibit 1 notes the advantages and disadvantages of each method. A discussion of each method follows.

Advisory Committee

Advisory committees are comprised of representatives of business, industry, and labor. One of the major functions of advisory committees is the identification of relevant content for vocational-technical programs (Burt 1967). Advisory committees also can identify emerging skills, especially if members are involved with the latest technology in their fields. Vocational-technical educators should ensure that consideration of emerging skills is included on their meeting agenda.

Advisory committee members believe that they have influenced program content, according to a statewide evaluation of secondary vocational programs in Wisconsin (Dale et al. 1980). At the postsecondary level, Sorensen (1974) found that state directors, vocational educators, and advisory committee members think that one of the most important roles of advisory committees is to identify program content.

*Excerpted and adapted from *Emerging Skills: Implications for Voc Ed* (Nelson and Halfin 1982, pp. 7-10).

EXHIBIT 1

TECHNIQUES USEFUL FOR IDENTIFYING EMERGING SKILLS: ADVANTAGES AND DISADVANTAGES

ADVISORY COMMITTEE

Advantages	Disadvantages
Provides information directly from local business, industry, and labor.	Information available from local business and industry may not include state-of-the-art technology.
Provides opportunities for obtaining information from state-of-the art business and industry.	

CREATIVE INSIGHT

Advantages	Disadvantages
Provides flexible opportunities for vocational-technical educators to participate.	Difficult to coordinate and to document.
Provides maximum potential for immediate application of information gained in vocational-technical education classrooms.	Requires continuing leadership of local administrator.
	Requires funding support for optimum effectiveness (workshops, conferences, and so forth).

DACUM PROCESS

Advantages	Disadvantages
Provides information about current business and industry technology.	Information available from local business and industry may not include state-of-the-art technology.
Produces high quality information.	Provides information about emerging skills only if specifically designed to do so.
Requires a minimum of time.	
Provides an opportunity to obtain information on competencies related to emerging skills.	

Exhibit 1—*Continued*

DELPHI PROCESS

Advantages	Disadvantages
Provides opportunities to obtain forecasts from experts representative of all geographic regions.	Requires the commitment of an extended time period by participants (some may not complete the process).
Produces high quality information.	Requires a considerable amount of staff time.

EVALUATION STUDY

Advantages	Disadvantages
Provides information about changing needs for skills.	Provides information about emerging skills only if specifically designed to do so.
Provides a means for easy and continuous collection of data.	

INDUSTRIAL WORK EXPERIENCE

Advantages	Disadvantages
Provides opportunities to obtain state-of-the-art knowledge and skills.	Availability of jobs may be limited.
Provides information about current business and industry concerns.	Available jobs may not provide state-of-the-art experiences.

LABOR MARKET SURVEY

Advantages	Disadvantages
Provides data on the composition of the existing labor market.	Information provided is influenced by economic cycles (during economic slowdowns job openings are underestimated).
Provides information on the projected job openings in each job category.	Identifies few emerging skills.
Provides information on recent trends in the labor market (when the data from a series of surveys are analyzed).	

Exhibit 1—*Continued*

STUDY, SURVEY, OR CONFERENCE

Advantages	Disadvantages
Provides opportunities to obtain information on a specific trend.	Requires that expert participants be available.
Provides opportunities to obtain information from experts.	Requires considerable expenditures.
Produces high quality information.	Requires a considerable amount of time and effort to organize, conduct, and report.
	Dissemination of reported information may be limited.

Creative Insight

The use of creative insight and analysis to identify emerging skills is not well documented. Some information on this approach is available for educators who are in the process of introducing new skill training for existing curricula or developing curricula related to emerging technologies. The identification of emerging skills or occupations usually begins with the acquisition of information on new research developments, processes, or technology through reading professional journals, participation in professional organizations related to the technology, or attendance at conferences or workshops where the new technology is discussed.

DACUM Process

The DACUM curriculum development process was designed to develop relevant vocational-technical education curricula. DACUM stands for "Developing A CurriculUM."

In the DACUM process, identification of the tasks and competencies required to perform a given job is accomplished by a panel of persons who are employed in the job, or who supervise those who are. These people meet with a DACUM facilitator to identify the functions or duties involved in performing the job. Specific tasks related to each function are then identified and sequenced on logical, psychological, or need bases. The originators of the DACUM process recommended that sequencing of tasks be based on the question "What do people need to do as they enter the job?" The end product of the DACUM process is a chart that contains all the functions and tasks required to a certain job, placed in an appropriate sequence.

Morton (1977) has indicated that the brainstorming atmosphere of the DACUM process stimulates the identification of emerging skills. The experience and knowledge of the panel members, of course, determine the types of tasks identified, so the inclusion of panel members who are working with new technology is important for the identification of emerging skills. (More information about DACUM is provided in chapter 6 of this publication.)

Delphi Process

A review of the literature indicates that the Delphi process has been successfully used to identify new and emerging

skills. This process was developed after World War II to provide a means for projecting trends related to military and international affairs. It has subsequently been applied to a variety of problems in education, business, and industry.

A Delphi study involves a panel of experts in a series of surveys. The panel is composed of persons who are knowledgeable about all or parts of the selected problem. Input from the panel is solicited by mail survey. This reduces the effect of personal interactions on the decisions of panel members.

In the first round, a list of trends or events related to the problem is obtained from the panel through general questions. The responses to this survey are synthesized and a rating scale is developed. The respondents are then, in the second round, asked to indicate the likelihood of occurrence, importance, and/or impact of the trends listed. Responses are summarized, and the area of consensus for each item is determined.

In the third round, Delphi panel members whose responses are not within the consensus area for an item are asked to modify or to write a justification for those responses. The ratings and comments obtained in the third round are summarized and returned to the panel. In the fourth round, the panel members are asked either to modify responses that are outside the area of consensus or to write a counter-argument to the responses that are at the other extreme of the response continuum.

The Delphi process elicits a wide variety of ideas and projections. It helps to derive consensus on most of the trends or items listed, but it also provides an opportunity for input that is not consistent with the majority of the members of the group. The arguments and counter-arguments often provide information about new trends and directions.

The Delphi process proved to be valuable in forecasting trends and events related to vocational education in Wisconsin (Arora 1974). Changes in a variety of areas, such as communications, demographics, manufacturing, agriculture, and transportation were predicted. For example, trends toward small cars, home computers, and automated manufacturing were forecast. The accuracy of those predictions is now apparent.

Evaluation Study

Since evaluation or follow-up studies typically involve vocational education graduates and their employers, they provide an excellent opportunity to acquire feedback on emerging skills. Although specific questions on emerging skills were not asked, evaluation reports from Oklahoma (Morton et al. 1977) and Wisconsin (Dale et al. 1980) suggest that vocational education programs in those states are, in general, keeping current with business and industry technology.

Industrial Work Experience

The importance of experience in business and industry for vocational educators is emphasized throughout vocational education literature (Elliott 1978). Work experience is often a requirement for certification of vocational educators. Many vocational education teachers have not had a recent opportunity to return to the occupation that they represent and have therefore not been able to remain current with technology through this means.

Programs have been established by some states and school systems to assist vocational educators in renewing their work experience. Teachers who have participated in programs that give them experience in business and industry indicate that these experiences are helpful in identifying new technology and the skills required to utilize it.

Another way, then, to identify emerging skills and incorporate related training

in vocational-technical education programs is to employ teachers who recently have been using skills related to new technologies. This approach is most feasible for expanding or new programs.

Labor Market Survey

Labor market surveys are conducted at national, state, and local levels. The U.S. Department of Labor provides frequent reports of trends in the labor market. State departments responsible for industry and labor affairs also conduct labor market surveys. Some local labor market surveys are conducted by local government agencies or by schools.

Labor market surveys identify the number of available jobs in specific job categories. Because the purpose of labor market surveys is to report employment trends, the information obtained is concerned only with jobs. Emerging skills are therefore not identified. In some surveys, however, emerging occupations are identified. These data can be useful to vocational-technical program planners.

Examples of surveys that have identified emerging occupations include one completed by the state of Washington. This labor market study identified several emerging occupations (Halverson et al. 1978). A survey of data processing jobs in Pennsylvania identified some skill areas that vocational-technical educators should emphasize (Cannon, Armstrong, and Armstrong 1978).

Study, Survey, or Conference

These activities usually involve bringing together or acquiring input from a panel of experts selected on a regional or national basis. Participants are normally chosen from a variety of fields. For example, the Wingspread conference "Changing Workforce Needs With Implications for Higher Education" (1978) brought together individuals from business, industry, vocational education, and higher education to discuss the impacts of changing lifestyles, demography, and technology on the skills required of workers.

The New York State Department of Education established a "Futurizing Committee" to review its business education curriculum and make recommendations for change (Wakin 1981). The committee recommended that vocational educators place more emphasis on problem solving, decision making, and human relations skills. Computer literacy was recognized as an important educational goal. The need for a better understanding by students of the United States economic system was emphasized. This study was seen as so effective that the process is to be utilized for all vocational education programs in New York (Freeborne 1981).

Hogue (1979) surveyed business people and distributive education coordinators in an attempt to identify emerging occupations. Two of the identified emerging jobs were related to international travel and commerce. Skills related to international transactions are apparently becoming more important.

Participants from agriculture, industry, labor, and government, in a symposium on the role of vocational education in the United States' economy, noted a variety of problems in forecasting (Van Ausdle 1978). Several participants suggested that forecasting must be a continuous process.

In addition to determining the institution's response mode (early, fast-follow, or delayed) and identifying emerging skills, the institutional planner must create a strategic planning process. A discussion of the steps involved in planning a high-technology program follows.

Steps for Creating Successful High-Technology Programs*

There are several ways to approach long-range planning. A "strategic planning process" is suggested here, in which assumptions about future conditions affecting the programming of a college are formulated. The assumptions should be based on observable financial, population, economic, and technological trends. Internal barriers and facilitating events also should be tracked and incorporated in the planning formula.

A strategic planning process will engage the planning group in identifying the most critical issues a college must address in the development of occupational programs and planning goals for a 5-year period. Further, it will assist those responsible for implementing the plan to focus on the activities and decisions of highest priority. An excellent source for planning literature is documentation produced through corporate strategic planning activities. This source can help a college learn the terminology and understand the thinking of corporations.

If there are several colleges offering technical education in an area, it may be advantageous for them to form a consortium or other organization for the purpose of addressing short- and long-range problems of mutual concern. This cooperative venture should enable them to share the costs of programs, including costs of staff, facilities, and equipment. The reduction of costly duplication and a cooperative rather than a competitive approach to relationships with industry should gain the goodwill and support of companies that otherwise might be reluctant to use the time of several executives on multiple advisory groups.

In order to target program improvement and development efforts most effectively, linkages with other agencies (e.g., the labor market information services, local employment service, and the local economic development agency) are necessary. These agencies can be helpful in obtaining essential human resource data for establishing program development priorities.

It is also critical to establish a long-range planning committee before initiating any activity to establish high-technology training programs. Such advisory councils are essential to getting these efforts off the ground. They are particularly important for colleges in urban areas, where there are high concentrations of manufacturing firms producing a broad array of products new to the marketplace. The sudden appearance of such firms and their products often creates uncertainty about the directions in which technology applications (and related occupations) are going. Visiting such firms and discussing their needs and plans with company representatives often only adds to the uncertainty. Thus, a major role of an advisory council is to provide an industrywide perspective on current and future technological (and related occupational) directions.

Process for Creating Programs

A 30-step process for creating successful high-technology training programs is presented here. Five major phases of activities should occur. They are (1) long-range planning, (2) program planning, (3) development, (4) implementation, and (5) evaluation and refinement.

Phase 1--Long-Range Planning

Step 1: Establish a High-Technology Advisory Council

To provide guidance on the current status and future needs of high technologies, representatives from leading industries in the area using those technologies

*Excerpted and adapted from *Preparing for High Technology: 30 Steps to Implementation* (Abram, Rose, and Landrum 1983, pp. 7-36).

should be asked to serve on a high-technology advisory council. Industry representatives should include those involved in long-range planning for their companies--individuals who can sense the needs of their companies 3 to 5 years in the future. Top corporate planners who have the direct support of their companies' chief executive officers can provide valuable input for college planning.

In addition to industry representation, the council should be comprised of faculty and administrators in the areas from which high-technology training programs likely evolve (e.g., electronics manufacturing, drafting). The council should serve as a resource and "clearinghouse" and will make recommendations concerning the directions the institution should take in high-technology training. The council should also be available for ongoing evaluation of existing programs and of their relationship to anticipated program offerings.

If the institution is located in a geographical area containing many colleges, it may be advantageous to explore the possibility of a cooperative task force for this phase.

When establishing a high-technology advisory council--

- select professionals from a variety of high-technology fields;
- provide an outline of expectations and powers of the council;
- include faculty and administrative representatives from disciplines likely to be involved;
- consider cooperation with other area colleges and universities with similar interests;
- include industry representatives who have some reservations about high-technology education as they may provide valuable input, especially on training areas to avoid; and
- include "traditional" program planners in the group.

Step 2: Develop a 5-year Plan for the New High-Technology Program(s)

Developing a 5-year plan encourages planning for eventually interfacing high-technology programs with existing and future curricula of the institution. In addition to anticipated programs and course offerings, the 5-year plan should detail expected staffing, facilities, equipment, and supply requirements. Consideration should be given to the substitution of scaled-down but fully operational models of expensive equipment (e.g., robot models) and less-expensive versions of system components (e.g., microcomputers instead of full-scale CAD hardware) in order to reduce the large capital outlay of a dedicated laboratory. Projected revenue generation should be estimated. Sequencing of new programs and courses and their relationship to existing or conceived curricula should be specified.

Most technical colleges already possess a nucleus of programs and courses for supporting high-technology training programs. Programs in robotics, automated manufacturing systems, computer technology, computer-aided design, computer-aided manufacturing, production management, "high-tech" maintenance, process technology, and communications technology in colleges across the nation are a result of the electronics, drafting, machining, quality control, manufacturing process, automotive, and management programs that have existed for years.

To determine whether an additional program is needed or the current program can be modified, the high-technology advisory council should consider designing a

survey to be administered to member firms. The survey form should be developed by council members to ensure that the terminology is understandable by industry and that the information requested is available. For example, survey questions might request information on whether firms hire from current programs in the college, on the skill categories in which technicians are needed but training does not currently exist, and on the projected number of new hires anticipated over a given period of years.

After information about local skill and knowledge needs is obtained, the administration, faculty, and council can begin to do the following:

- Determine the needs for program expansion, program modification, and addition or deletion of the courses or new program(s).

- Estimate equipment and facility needs, staffing (full- and part-time), curriculum development support, faculty retraining areas, and related support costs of supplies, equipment maintenance, lab technicians, instructional materials, and printing (e.g., texts may not be available on the subject).

- Arrange the development projects in some order of priority. Priorities may change depending on the assistance provided by concerned firms. Such assistance may include part-time staff, equipment donations, cooperative training arrangements that enable students/employees to obtain hands-on experiences within the firm, and temporary work opportunities for faculty to learn new skills on the job.

The 5-year planning document should serve as a reliable statement of the institution's intentions, but should be adaptable to reflect changes in the economy, enrollment, industry trends, and so forth.

When developing a 5-year plan for the new technology, consider the following:

- The more thought that is given to interfacing with existing programs and courses, the easier it is to select equipment, facility, and support material. Existing programs and courses often can serve as stepping stones in planning and developing the new high-technology program(s).

- The 5-year plan is not to be "cast in stone."

Phase 2--Program Planning

Step 3: Develop Design Criteria and Performance Goals of the Proposed Program(s)

With the assistance of the high-technology advisory council, as much information as possible about the particular high-technology discipline should be assembled and evaluated. From this information, an analysis should be made to determine what skills and knowledge should be emphasized in the proposed program(s). When these are determined, design criteria and performance goals can be detailed. Design criteria should be statements that provide a broad overview of the specific intent and objectives of the program(s). Competency-based performance goals are suggested alternatives to meeting these objectives. If possible, consultants from the industry should be used to ensure that all objectives meet the current and projected needs of the field. Thoughtful attention to design and performance goals facilitates the development of individual speciality courses.

As criteria and goals are developed, follow these guidelines:

- Work with experts in the chosen field.

- Address all related areas.
- Have specific objectives for the program(s) in mind.
- Write the statements so that they allow for flexibility in course development.

Step 4: Identify Department and Faculty Best Suited to Support and Develop the Program(s)

If the institution has several departments within which high-technology programs could conceivably be housed, an evaluation must be made as to which department(s) best meet the specific needs for the desired outcomes. Decisions must be made to determine what the goals of the program(s) are--hands-on experience, engineering-related skills, theoretical knowledge, and so forth.

Other considerations that affect these assignments include the ability of the faculty to retrain for the specialty, the availability of faculty to work with corporate representatives to design the program(s), and the relationship of the new program(s) to existing courses.

Given some of the trends in high-technology industries, the best assignment of a new program to a department within a college may not be immediately obvious. For example, a program to prepare technicians to install, maintain, and repair automated manufacturing equipment may need to tap the educational activities that cultivate mechanical skills, as well as those that cultivate learning in electronics and microprocessor skills. This trend of crossing formerly distinct disciplines is taking place today in automotive technology programs, where competent automotive technicians also need to acquire a firm foundation in electronics and microprocessor-controlled systems. Although several departments may therefore need to share in a new program's operation, specific responsibility and authority should be assigned to one department, in order to assure the future development of the program.

After the department and faculty for the new program are identified, the actual curriculum development can proceed.

In identifying the department and faculty, consider the following:

- The type of instruction planned for the program
- Backgrounds and adaptability of existing staff
- Equipment and facility requirements
- The goals of the program and where in the institutional setting they can be best accommodated

Step 5: Formalize a Program Advisory Committee

For every program to be developed, there should be a specialized program advisory committee with representatives from industries that are directly involved with the day-to-day operations of the specific technology in question. This committee can provide the institution with essential technical information and resources for curriculum and course content development.

The program advisory committee has the following responsibilities:

- Defining the overall courses and goals
- Describing the types of positions for which the program completers will qualify
- Reviewing existing courses for program applicability
- Describing the content of new and modified courses

- Reviewing drafts of course outlines and/or course competency statements
- Recommending equipment and facilities
- Recommending consultants and part-time teaching staff

Persons on this committee should have an appreciation for education and training processes as well as be knowledgeable about the technical aspects of the field.

The members of the high-technology advisory council can be very valuable in securing the best members for program advisory committee(s) from within those firms that plan to hire future graduates of the new high-technology program(s). The training and education departments of companies are also good sources for committee representatives.

A committee should include persons having a supervisory relationship to the kinds of technicians being trained so that the committee members can provide information on skills needed on the job. Supervisors are also the individuals who often make hiring decisions and promotional recommendations, and who look to a college program for new employees if they know the program meets their requirements. Key faculty and administrators involved in the program should also be members of this committee.

Because many new programs may have implications for baccalaureate programs and student entry requirements in universities, it is a good idea to include representatives from the most appropriate disciplines at local universities and high schools. These representatives can assist in future articulation and help promote the new program.

When formalizing a program advisory committee, do the following:

- Contact the training departments of area companies for recommendations for program advisory committee members.
- Formally acknowledge volunteers. Their input and support will have a significant impact on the credibility of the program.
- Provide members with guidelines of expectations.
- Include small industries when selecting committee representation. These "job shops" account for a large percentage of usage and employment in high-technology fields, though at a slower pace. They may project a more realistic growth rate than larger interests.

Step 6: Establish Faculty, Administrative, and Community Support

It is essential that those faculty, administrators, and community people to be included in the development and implementation of high-technology programs be involved at the earliest possible point in the process. Faculty input should be solicited regarding supportive and "feeder" courses, and administrative support should be obtained regarding the programs' adherence to the institutional plan. Similarly, representatives of local firms on the high-technology advisory council will be aware of ongoing activities and plans to meet their specific training needs. The local television and print media also should begin informing the community about the new plans and activities underway for new programs and existing offerings.

When establishing an institutional committee, do the following:

- Include all affected college personnel in the development process as early as possible.
- Use community resources for both input and publicity.

- Involve faculty or administrators in departments whose courses will be needed for supportive instruction and whose enrollment may be drastically affected by new program development.

Step 7: Develop a First Draft of Program Requirements and Specifications

Before input and assistance can be requested from the program advisory committee or other consultants, a preliminary outline of the new high-technology program must be developed. A working document containing the recommended curricula--including suggested supportive courses as well as tentative specialty course titles and descriptions--should be available for review in time for the first program advisory committee meeting. Additional items that should be included in this preliminary packet are as follows:

- Suggested faculty qualifications and staffing recommendations (e.g., paraprofessionals, lab assistants).
- Equipment requirements.
- Instructional material suggestions.
- Facility requirements (e.g., renovation of existing facilities, new facility construction, facility rental, leasing from available sources). Budget projection may also be a part of the process.

Institutional formats should be kept in mind when preparing the layout of this document. This will facilitate transfer of the information from the rough draft to required forms as necessary. The document should always be viewed as a base from which to work and it will undoubtedly undergo many refinements.

When developing program requirements and specifications, do the following:

- Consider the first program specifications list to be a working draft, and expect changes to occur in it.
- Present the working draft for review at the first program advisory committee meeting.
- Include all relevant activities and projected expenses of the draft, not just curriculum content.
- Include institutional requirements for program and course approval.
- Observe state and regional requirements for program and course approval.

Step 8: Analyze Cost-Effectiveness of Program(s)

One of the most controversial issues in the development of high-technology training programs is the expense associated with them. At this time, an evaluation of alternatives should be made concerning equipment (e.g., purchase, lease, consignment, time-sharing with industry, grants) and facilities (e.g., renovation, construction, lease, rent). Along with the acquisition of these items, consideration must be given to maintenance and service contracts and other special requirements (e.g., climate control, space allocations, noise control, power requirements). The projected costs must be carefully weighed against the benefits of offering such high-technology programs. Some issues that must be taken into account include revenue production, employment opportunities for graduates, institutional or governmental goals and objectives, client or community demand, and so forth.

This is the first major decision point at which the college must decide to continue, postpone, or discontinue the plans for high-technology offerings.

When analyzing program cost-effectiveness, do the following:

- Evaluate carefully all costs associated with the program (e.g., for training, equipment, facilities, and so forth).

- Try to project a reasonable time line for paying back the capital investments in the program.

- Consider all alternative methods of offering the training.

- Discontinue the development of the program if quality instruction is compromised by high costs and slow or no payback. There must be complete support for the program to succeed.

- Consider the possibility of postponing the program. A delay in implementation may make the program much more viable.

Phase 3--Program Development

Step 9: Submit Appropriate Applications and Budgetary Documents as Required in Institutional Procedures

If the decision is made to continue with program development, this is the time to begin the institutional approval process. This should be done early to provide adequate time for the approval process to be completed and to avoid delays at critical points later.

When preparing applications and budgetary documents, do the following:

- Carefully follow all necessary procedures.

- Explain procedures, applications, and outcomes of such programs more extensively than usual to staff. New concepts are often threatening to people.

Step 10: Convene Program Advisory Committee

The working document prepared in step 7 should be distributed to all committee members. The suggested curricula should be carefully reviewed. The appropriateness of sequencing and supportive courses as well as credit hour requirements should be examined. The proposed specialty courses should also be reviewed. Initial feedback should be noted from the meeting.

The program advisory committee should provide valuable input about the type and amount of equipment needed for training. Considering the expense of acquiring this type of equipment, the members should be queried about alternative methods of procurement. Approximate price ranges should also be determined at this time, and basic facility specifications should be addressed to coincide with equipment requirements.

Placement possibilities for graduates are an important consideration for any occupational program. The advice of the program advisory committee should be of particular value in determining targets for employer needs assessments and publicity materials. Professional organizations and unions should not be overlooked.

When convening the program advisory committee, do the following:

- Make sure that all program advisory committee members understand the committee's function.

- Stress the importance of each member's contribution.

- Utilize the committee on an ongoing basis.

- Keep committee members abreast of all developments concerning the program at the institution.

- Include the names of industry representatives in publicity information packets.

- Provide representatives from industry with information about the procedures for program development. Don't take anything for granted.

- Spotlight industry representatives when giving credit for the program, no matter how much time has passed in the interim.

- Remember the importance of a well-organized and representative program advisory committee in documenting the support from industry and the credibility of the program.

Step 11: Conduct Needs Assessments on Both Employer and Student Interest in the Program(s)

In order to determine employment outlooks for graduates of the new program, a survey of job opportunities must be conducted. This survey should be targeted for current potential employers and for those companies that might logically be expected to enter the field in the near future (e.g., traditional drafting or design shops for graduates of CAD programs). Realistically, there will be no actual graduates of the program for 2 to 4 years. This makes it necessary to request information about future employment projections as well as about current needs.

The employer survey also may include questions about their needs to upgrade or retrain their employees, and whether the new program would meet those needs. Additional queries about the levels of education and approximate salary ranges appropriate for jobs in the particular field also should be considered. Salary ranges could serve as a drawing point for recruitment literature.

If the employer survey is conducted early enough in the program development process, it can serve as an additional resource for appropriate curriculum content. A brief description of the program, followed by a list of suggested components, will fulfill this objective. The components should have a rating scale to determine their importance to prospective employers. Blanks provided at the end of the list give respondents an opportunity to add ideas.

An often used approach to developing a curriculum plan is through the Develop A CurriculUM (DACUM) process. DACUM produces a profile of competencies required in an occupation and can also be used as an evaluation instrument for training programs. (More information about DACUM is provided in chapter 6 of this publication.)

Student interest surveys serve two purposes. The most obvious is a preliminary determination of current interest in pursuing training and education in the particular area. The second is one of publicity, as well as presenting students with new options perhaps never before considered. The questionnaires need to be administered both to current college students and to high school students. The survey for current college students should include questions about--

- immediate interest in the proposed program,

- intent of attending full-time or part-time,

- pursuing the degree of certificate or just taking a few courses for special interest,

- willingness to change declared major, and

- desired outcomes (e.g., new job, advancement, and so forth).

The high school survey should be similar, but need not go into quite as much detail.

When completing needs assessments, do the following:

- Use a variety of sources for suggestions regarding to whom the survey should be directed.

- Use the questionnaires as instruments to gather information about as many areas relating to the program as possible.

- Keep the survey instruments simple in order to ensure a better rate of response.

- Organize the survey instruments so that results can be compiled and analyzed easily.

- Ask individuals representative of each target audience to review the instrument to be used in surveying that group. Revise the instruments based on these reactions.

- Make follow-up contacts as necessary. Don't be discouraged by a low percentage of response.

Step 12: Analyze the Needs Assessments

After receipt of responses to the two needs assessments (completed in step 11), a comprehensive analysis and interpretation of the results should be performed. Employment opportunities should be tallied. Responses should be reviewed for feelings about the appropriate level of education required for the positions sought. The anticipated growth rate in the field should be checked by comparing the current employment capacity to what is projected for the next year and the next 5 years. The growth rate must be taken into consideration especially in the high technologies, since they are areas that not all companies will have started utilizing. For this reason, even though the immediate employment opportunities may not be great, the projected jobs are extremely important. If curriculum component feedback was solicited in the survey, compare the ratings of the given components to their planned importance within the curriculum as it was designed. Review written-in suggestions to see if any necessary aspect has been overlooked. Check whether employers would recommend the program to their present employees for upgrading. Positive responses to this last question can be considered an endorsement of the concept of the proposed program.

Student interest surveys can provide a basis for estimating the number of persons considering training in the particular field. This may aid in determining staffing and course requirements. Responses must be compared in terms of passing interest versus genuine commitment to following through with the training (e.g., would like to take a few courses versus would pursue a degree).

When comparing the employer responses to the student interest responses, three distinct outcomes can occur. Ideally, employment possibilities and student interest will balance. If employment opportunities are strong but student interest is low, the institution may wish to undertake an aggressive publicity campaign to educate current and potential students about the possibilities. (At this point, impressive salary figures are helpful. It is possible that the public is not yet aware of what these new fields have to offer. The educational forum may help to fill this gap.) If, on the other hand, there is high student interest but low job opportunities (even long-range), the institution should seriously evaluate the reasons for offering the program at the present time. In the current economy, there cannot continue to be programs that produce well-qualified graduates for nonexistent careers.

The results of the surveys bring the college to another critical decision point about continuing the development of the new program(s).

When analyzing needs assessments, do the following:

- Consider responses carefully to evaluate the direction the program should take. Where are the needs?

- Make a careful assessment about the viability of the program. Are there actually opportunities for graduates at this level?

- Use responses to assist in determining the directions for publicity.

- Pay attention to negative responses. Carefully review the reasons for them.

Step 13: Determine Equipment Requirements

With the assistance of the program advisory committee and/or available consultants, specific equipment requirements for the new program should be determined. The ratio of equipment to students should be taken into consideration. Equipment that is adaptable to changes and expansion is more economical in the long run and should receive strong consideration. Retrofitting of existing equipment should also be explored.

Equipment also should be selected with space consideration in mind. Multiple numbers of certain items may be desirable for instructional purposes, but may be out of the question in relation to facility size. In this case, class size should be reviewed. In addition, support and service requirements of equipment should be carefully analyzed. If computers are required, the software should be identified and chosen before the hardware is selected.

At this point, equipment lists should be as close to final as possible. When determining program requirements, do the following:

- Consult with experts in the field to see what equipment suits education and training needs best.

- Consider the student to work-station ratios.

- Check with vendors to compare educational support packages.

- Find out what equipment industry is using and try to find affordable program equipment that will conform.

- Consider space restrictions.

- Purchase less than top-of-the-line equipment if the same applications and concepts can be taught with less expensive models.

- Remember the importance of instructional quality. Don't sacrifice it for inexpensive, but obsolete or inappropriate, equipment.

Step 14: Submit Grant and/or Funding Applications

If the college administrators decide to continue with the development of the new program, funding assistance should be sought. If possible, monies for consultants should be requested (unless free consulting services are available from local corporations). All aspects of program development should be considered. Special contract costs, support personnel, supplies, publicity, and the like are all realistic expenditures.

Some sources for funding are the state departments of education, trade or professional organizations (such as the Society of Manufacturing Engineers), and corporations dealing in the high-technology fields. The Jobs Training Partnership Act puts a high priority on retraining displaced workers, so the state governor's office administering the Act should be contacted as well.

When submitting grant or funding applications, do the following:

- Investigate all feasible funding sources.

- Detail all aspects of program development and implementation.

- Investigate the possibilities of equipment donations from corporations.

- Contact all professional or trade organizations that may be potential funding sources.

Step 15: Analyze and Develop Specifications for Facility and Equipment Requirements

After the equipment specifications list is finalized, plans for facility construction, renovations, or adaptation must be developed. Special requirements for proposed equipment must be considered.

It should be evident that there is more than just square footage to be considered when designing a facility. Power, lighting, and water supplies are vital to efficient operation of all aspects of high-technology training. Storage space for supplies and tools must be included. All these items should be handled at the preliminary stages of development.

When analyzing and developing specifications for facility and equipment requirements, do the following:

- Make sure that facilities allow for all equipment support requirements.

- Involve faculty in facility planning.

- Observe safety requirements.

Step 16: Prepare Bid Specifications

Once equipment and facility requirements are known, they must be prepared in a format for bid requests. When specific brands of equipment are required, they should be noted, including the rationale. Where options and features are necessary, they should be specified. If a particular model is not a requirement, alternative makes or models with the desired features should be indicated. The entire equipment list should be prepared in this manner and requests for price quotations sent to appropriate firms known to be reputable suppliers of the type of equipment desired. The program advisory committee is a good source for recommendations of suppliers.

Facility requirements should be similarly specified, noting where compromises will be acceptable. Safety requirements should in no way be slighted. All specifications should be detailed. Again, whether it be for renovation of existing facilities or for new construction, bids should be solicited from reputable architectural and construction firms.

When preparing bid specifications, do the following:

- Provide guidelines about where substitutions and/or alternative selections will be considered.

- Deal with reputable suppliers and firms.

- Consider future as well as current equipment and facility needs.

- Involve the program advisory committee. It may be a good source for suggestions as to vendors.

Step 17: Submit Program(s) and Courses for Institutional Review and Approval

At this point, the program and its speciality courses should be well on their way to being firmly conceptualized. All preliminary reviews should have been completed in step 9. Final preparations should be made now for institutional approval of the curricula. Any committee members, department chairpersons, or administrators whose endorsements are required should be fully apprised of all aspects of the program. Any remaining questions or concerns should be resolved.

When seeking institutional review and approval, do the following:

- Make sure that all concerned faculty, administrators, and staff are fully apprised of the program and its intent.
- Follow institutional procedures carefully.
- Be aware that extra public relations or informational sessions may be required to overcome skepticism.

Step 18: Obtain Facility and Equipment Bids

When responses to bid requests begin returning, they must be carefully reviewed. Several things must be checked in addition to the actual lowest dollar figure. For example, college administrators must ascertain whether required specifications, features, options, instructional packages, and so forth are included in the quotations. Delivery and installation conditions should be read thoroughly and understood. Service contract requirements must be carefully examined to assure compliance with all desired specifications.

Facility bids should also be scrutinized for conformance to specifications, and safety requirements must be kept at the top of the list. When reviewing the bids, do the following:

- Make sure that all proposals meet the requirements.
- Maintain program quality even if it does not allow for the lowest dollar figure.
- Provide for safety.

Step 19: Begin Facility Renovation or Construction

When contracts are awarded, construction and/or renovation should begin immediately. If the college does not have a construction manager, an administrator should be appointed to check regularly that construction is proceeding according to schedule, review any construction changes, and obtain necessary approvals for changes in construction or materials used.

Keep in mind this axiom for facility renovation or construction:

- Begin construction as soon as possible to facilitate timely set-up.

Phase 4--Program Implementation

Step 20: Order Equipment and Materials

Based on the bids reviewed, appropriate suppliers of equipment for the program should be selected and the required items ordered. Textbooks, audiovisual aids, and so forth must be acquired in time for efficient program start-up. Any consumable supplies needed for equipment operation and maintenance should also be on hand for start-up. All these things should be available as soon as possible, especially those specifically needed for introductory courses.

When ordering equipment and materials, do the following:

- Order supplies and materials required for support and maintenance of equipment.
- Ascertain that all peripheral requirements for the program are ordered.
- Remember teaching aids when ordering materials.

Step 21: Retrain Current Faculty and/or Hire New Faculty

Faculty retraining requires considerable time and forethought. Learning new

technical applications and gaining practical experience in industry are especially important for existing full-time faculty, who may not have kept current with recent advances in their fields of expertise.

The first step in this process is for faculty members and administrators to determine the skills and knowledge to be acquired and determine which faculty should be retrained. Retraining might be accomplished through sabbatical leaves, seminars, conferences, or programs from vendors. Consideration should be given to offering short sabbaticals for a summer or one school term.

If preferred, new faculty may be hired for the program. It is recommended that these persons be well-versed in current applications of the field, as well as having strong instructional abilities and understanding of educational objectives and priorities. Obviously, the capability of the instructor to adapt easily to the changing requirements of both education and industry is a favorable asset. Other alternatives are to hire skilled employees of local firms to teach inservice specialty courses for faculty in the evenings, early mornings, or weekends.

When determining faculty staffing, do the following:

- Make an effort to retrain existing instructors.
- Select new faculty who have an understanding of the relationship between education and industry.
- Use program advisory committee members as information sources when searching for qualified new instructors.
- Use program advisory committee members when retraining existing instructors.

Step 22: Publicize New Programs

Publicity information should be distributed announcing the implementation plans for the program. Professional and trade organizations often have their own publications in which new training programs can be announced.

An aggressive publicity campaign should be directed toward potential students at area high schools. The program, curricula, facilities, equipment, job opportunities, and salary scales of graduates of such programs are good selling points.

Media publicity also may prove effective. Newspaper articles, radio interviews and reports, or television feature articles often highlight educational opportunities. Strategic use of press releases about facility renovation or construction, equipment acquisitions, and so forth can serve as effective publicity.

To ensure success for efforts to publicize new programs, do the following:

- Send publicity materials to all who were surveyed for the needs assessment.
- Use press releases when major steps are undertaken in program development.
- Publicize the new program to high school students and to industries having even remote ties to the field.
- Involve the college(s)' public relations office in this effort.
- Involve the college(s)' student recruiting (admissions) office in the effort also.

- Take into account the publicity impact of prospective job titles and salary levels for graduates of the new program.

- Take advantage of opportunities that program advisory committee members may have to promote the program.

Step 23: Occupy and Set Up Facility, Equipment, and Materials

When the facility is finished, it should be set up and occupied immediately. Accurate inventories developed at this time will make future recordkeeping and updating easier. Laboratory and classroom layouts should be reviewed and pilot-tested for effectiveness. Materials and supplies should be catalogued and stored with consideration for both security and accessibility. Auxiliary items, such as screens, chalkboards, desks, and so forth, should also be put in place at this time.

When setting up the facility, equipment, and materials, do the following:

- Occupy the facility as soon as possible.

- Keep accurate records and inventories of incoming equipment and supplies.

- Consider both accessibility and security in storing supplies and equipment.

Step 24: Prepare Detailed Course Syllabuses

Using the design criteria and performance goals developed earlier, a syllabus should be developed for each speciality course. Specific objectives, demonstrations, assignments, and other activities should be detailed. Since the courses are being taught for the first time, adjustments should be anticipated; however, the more thought given to structure before starting the courses, the smoother the flow will be, even with the changes. Grading procedures, classroom policies, and so forth should be spelled out in course syllabuses to provide students with a clear indication of institutional expectations.

Regular meetings of full- and part-time staff teaching the courses should be conducted to ensure that the material is properly sequenced and that there are neither gaps nor unnecessary repetition in instruction. When preparing course syllabuses, do the following:

- Specify course requirements in detail.

- Begin with a competency-based curriculum.

- Ensure that instruction conforms to the course syllabus as closely as possible so that all students receive the same instruction and have the opportunity to begin succeeding courses at equal skill levels.

Step 25: Conduct Orientation For New and/or Part-time Faculty

To assure that all instructors of the program are aware of the institutional objectives, it is advisable to hold an orientation and information session with all involved faculty. This session should include a review of the syllabus for the course to be taught. In general, anything that will facilitate the instruction of the program in a uniform manner should be reviewed. Questions should be answered about any topics of concern. If possible, all support personnel also should be available for introduction at the meeting. If available, a general handbook of institutional guidelines and procedures should be distributed.

When conducting the orientations, do the following:

- Include all people who will be teaching the new courses.

- Present as much information about expectations and procedures as possible.

- Provide for questions or concerns.

Step 26: Provide High-Technology Counseling

One person should be designated as the counselor for high-technology programs. This should be done before publicity is released, thereby providing a contact for student inquiries.

In the early stages of a new program, the departmental faculty members will be the most knowledgeable persons about the program, including entry requirements, program goals, and employment opportunities. Because they will have been closest to the curriculum development process, they are probably the best counselors for students interested in the new programs.

When providing high-technology counseling, do the following:

- Provide prospective students with information and with guidance into supportive courses as soon as a new program is officially approved, even if specialty courses are not ready to be offered immediately.

- Designate a staff person (or persons) to disseminate program information and handle inquiries.

- Use any delay in availability as an opportunity for developmental education for students in need of basic skills remediation.

- Permit staff persons other than those designated, to answer questions only if they are fully informed on all aspects of the new program.

Step 27: Implement the Program(s)

As soon as the facility is ready, equipment is operable, and staff are available and prepared, speciality courses should be offered as detailed in the curriculum. The sequence should be determined by prerequisite requirements. Feeder courses should be offered every term in order to assure continuance of the program. Sequences should be established to accommodate both full- and part-time students. Ample opportunities should be provided to upgrade the skills and knowledge of current employees and displaced workers.

When implementing the program, do the following:

- Offer courses in a sequential manner with consideration of prerequisites.

- Consider supportive course offerings.

- Keep in mind the importance of continuing to offer introductory or "feeder" courses for the continuation of the new program.

Phase 5--Program Evaluation and Refinement

Step 28: Evaluate the High-Technology Program(s)

Toward the end of the first term, a preliminary evaluation of the new program should be conducted. Students should be asked to evaluate both the faculty and the quality of the program. Faculty members should evaluate instructional materials, methods, effectiveness and appropriateness of course syllabuses, and so forth. Suggestions for improving the program should be solicited from all students and staff.

When evaluating the program, do the following:

- Conduct an evaluation near the end of the first term.
- Consider suggestions made for improving the program.
- Inform the program advisory committee of the evaluation results.
- Be aware of the importance of gathering evaluative information from all people involved in the program: students, staff, and faculty (both part- and full-time).

Step 29: Adjust Courses and Teaching Strategies According to Evaluation Results

After all evaluation results are tabulated, they should be carefully reviewed for indications of shortcomings in any area. Caution should be used when attempting this, however, since some students are not satisfied under any circumstances, and there are always "rough spots" the first time any course is offered. It is important to watch for definite problem trends in any area. If and when they are found, solutions should be sought.

When adjusting courses and teaching strategies, do the following:

- Consider carefully the evaluation results.
- Look for trends that may indicate a need for change. One indication of such a trend is similar negative findings for students and staff.
- Resist becoming discouraged if something needs to be changed. This is to be expected for virtually any new program.

Step 30: Continue to Review and Refine Program(s), Courses, Methods, and Equipment as Dictated by Ongoing Evaluation

As the advanced courses in the sequence are delivered, evaluation should continue and be expanded. Students should evaluate instructional techniques and faculty should evaluate the new program. As program graduates are placed in the field, evaluation should also be sought from employers. Valuable feedback regarding the appropriateness of instruction as related to "real world" situations can be obtained in this manner. When the program advisory committee meets, members usually will have input for this aspect of evaluation. Often, either their companies have employed students or they have had contact with companies that have done so and will have firsthand knowledge of both the program objectives and the results.

Equipment and laboratory needs as well as the currentness of textbooks and other instructional materials should be reviewed periodically. Updating should be carried out whenever possible.

When reviewing and refining the program, do the following:

- Evaluate the program and its courses continually.
- Use evaluative information to refine and revise the program.
- Invest the time needed to obtain information from employers program graduates.
- Seek the input of the program advisory committee when evaluating the program.

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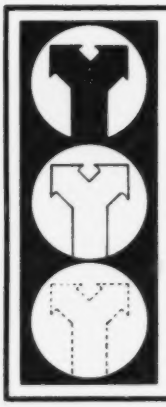

Part II
Stages of Curriculum Development

Chapter 3
Assessing Needs

A Model for Assessing Business, Industry, and Labor Needs*

A major goal of postsecondary institutions (community colleges, technical colleges, and technical institutes) is that of providing the educational experience required for individuals to enter and remain in the labor force. To effectively achieve this goal, it is necessary for postsecondary institutions to work closely with business, industry, and labor (hereafter referred to by the acronym BIL) to continually monitor employee education and training needs. To aid in meeting this goal, members of the National Postsecondary Alliance, with technical assistance from the National Center for Research in Vocational Education, have developed this BIL needs assessment model.

This section outlines a systematic approach to the process of reviewing employer and employee needs. The system presented is not meant to duplicate or replace the regional or state systems designed to provide general planning information. Neither is it meant to replace specifically focused occupational or task analysis systems. Rather it is meant to fill the need for a cost-effective, locally focused data collection system that will provide a basis for a postsecondary institution to make decisions relative to pre- and post-employment education and training programs.

The BIL Needs Assessment Model

Although simple in principle, the process of determining the specific education and training needs of employers can result in the necessity of resolving fairly complex issues and the collection and analysis of extremely large volumes of data. It is desirable to plan and organize each activity as far in advance of execution as possible. Figure 1 provides an overview of the BIL needs assessment system. Each procedure is discussed below; some processes are dealt with in more detail in separate sections.

Step 1: Identify BIL Project Coordinator

Due to the desirability of distributing the workload of the BIL needs assessment among a number of individuals, it is necessary to identify an individual who will have the primary responsibility of coordinating the project.

*Excerpted and adapted from *A Model to Assess the Education and Training Needs of Business, Industry, and Labor* (Nasman 1981, pp. 1-16).

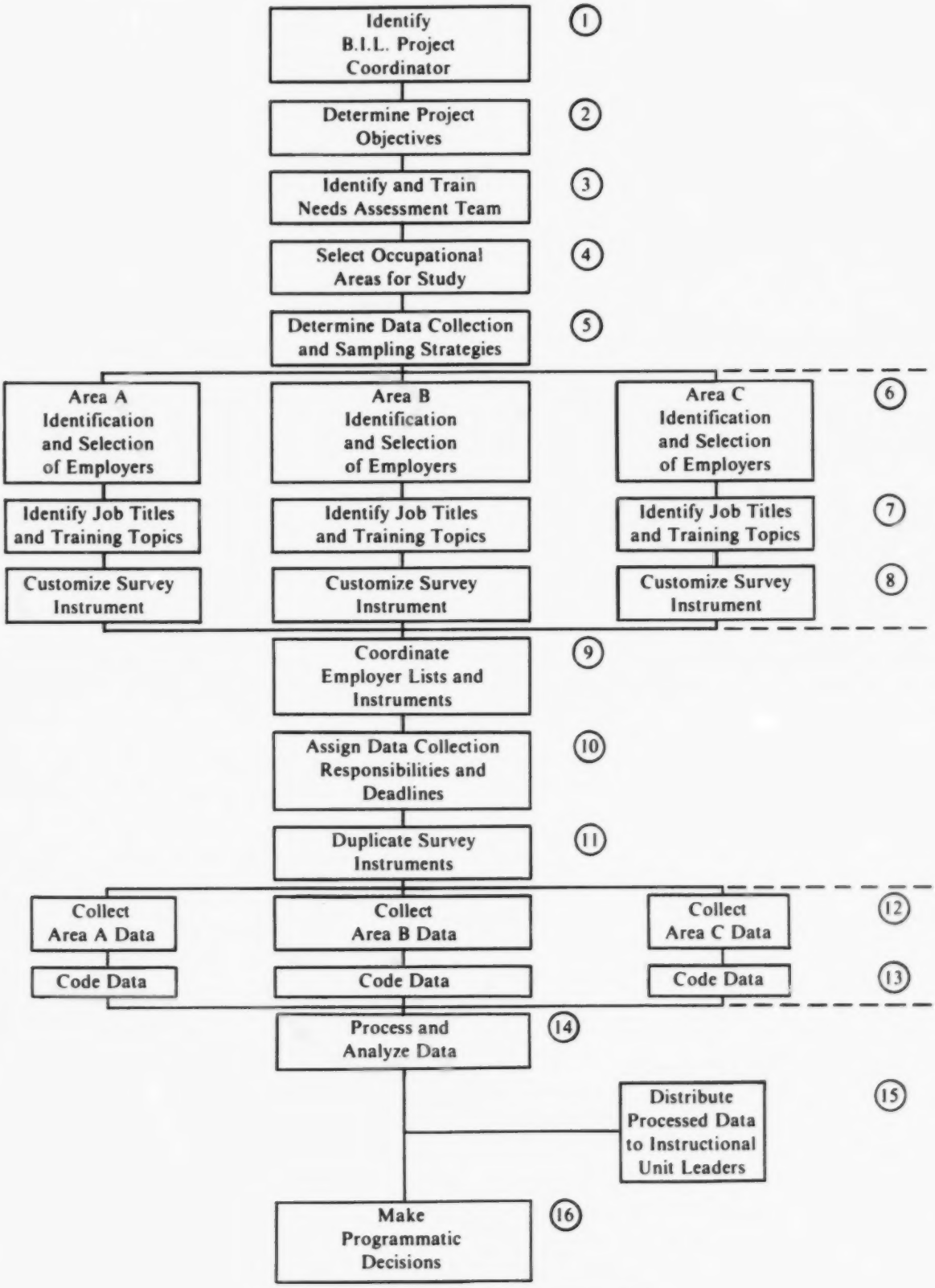

Figure 1. BIL needs assessment system

Step 2: Determine Project Objectives

The specific purpose or objective of the BIL needs assessment project will vary from institution to institution and from one application of the model to the next. Because the degree of rigor that is applied to various procedures will determine the appropriate application of the results, it is important to state the objectives clearly and specifically at the outset. For example, if the primary objective is to identify possible expansion programs, the selection of employers to be sampled would be different than if the objective is improvement of existing programs. In the latter case, it would be more useful to include a greater percentage of employers who have hired program graduates than in the former.

It is tempting to try to meet a maximum number of objectives with each application of the model. If one yields to this temptation, it is likely that the project will be overtaxed by attempting to cover an excessively broad scope of content. Pilot testing suggests that it may be impossible to develop objectives that are too narrow for a particular application of the model.

Step 3: Identify and Train Needs Assessment Team

The needs assessment team who will have maximum influence on the quality of the project. The degree of commitment of team members will be influenced by how close they are to applications of the data collected. For example, a division director will have more interest in developing instruments and collecting data to be used in division program expansion than in expanding continuing education offerings. Of course, the reverse is also true. Even though this may appear to be a statement of the obvious, in at least one pilot-test site, some assessment team members were less than enthusiastic about collecting data for other sectors of the college. Even though there were other logical reasons for selecting these individuals, the process suffered from a basic human factor.

Training for the team should include an overview of the project, clarification of all terminology used in the data collection instruments, and if the interview technique is selected, a series of practice interviews. These should be followed by a group session where experiences of team members are shared, and collected data is reviewed and coded to ensure consistent application of the interview instrument.

Step 4: Select Occupational Areas for Study

The selection of occupational areas has two aspects. The first was dealt with in some degree in the section on objectives. It may be that the application of the BIL needs assessment model will be limited to one specific occupational area. This is especially suggested for the institution's first experience. The second aspect of occupational areas relates to employers and instrument design.

Even a very limited survey results in a disruption of the workplace. Ideally, one would only ask questions of an employer that are directly applicable. This would require that a separate instrument be developed for each employer, which is unrealistic. The compromise suggested is to identify the major occupational areas or clusters and develop a version of the instrument for each area. The employers to be surveyed are placed in groups corresponding to the occupational areas identified, and the instrument is then more relevant in each application. Because of the design of the basic instrument format, having 8 or 12 versions of the instrument does not cause difficulty in coding or processing the data for analysis.

Step 5: Determine Data Collection and Sampling Strategies

There are three basic data collection techniques commonly used to collect data in this type of project. The are as follows:

- Personal interview
- Telephone survey
- Mail survey

The most effective technique is the personal interview. It also provides the greatest opportunity for positive public relations benefits and increased institution/employer communications. The telephone survey may be a desirable substitute for the interview in the case where the employer is a small business owner and has the required data on the "tip of the tongue." An example might be a shop where only 3 or 4 employees have been hired in the last 5 years. If a large number of employers are to be surveyed, a mailed survey may be the only affordable alternative. However, the rate of response to mailed surveys of this type is rarely very high. Additional details on these survey techniques may be found in a later section.

Step 6: Identify and Select Employers

At this point, a list of employers to be surveyed should be prepared for each occupational area identified in step 4. The team will be divided into subteams for each occupational area. Each employer included on the list should be assigned an identification number to be used in coding. This number can identify type, size, or other relevant information. For example, 4000 to 4999 may be health related, 4100 a small clinic, 4900 a large hospital, and so forth.

Step 7: Identify Job Titles and Training Topics

The term "job title" as used in this discussion refers to the name of the positions for which the institutions is (or might be) providing preemployment education or training.

The purpose of identifying job titles is to provide a listing to be used on the BIL needs survey instrument (see figures 2 and 3). The job titles will appear in two different sections of the survey instrument. The first includes those jobs for which the institution is presently preparing people. The second is a list of those jobs for which the institution is not presently preparing people but might if a sufficient need exists.

The job titles should be kept fairly general (i.e., "Welder" rather than "Lincoln Welding Machine Operator IIa"). This is because different jobs at different companies sometimes have the same title, whereas the same job at different companies sometimes has a different title. Keep in mind that the purpose of this assessment is to identify areas where modifications may be required to meet employer needs. Once specific areas have been identified through this assessment, the necessary details will be collected by means of a thorough occupational or task analysis, such as a DACUM analysis. (Information about DACUM is provided later in this book in chapter 6, "Developing Curriculum Content.")

Job titles may be identified by examination of program brochures, catalogs, discussions with key program personnel, and through input from advisory committees. Each job title listed should be assigned a unique identification number which will be used in coding and analyzing data. Also, each instructional unit of the institution should be assigned an identification number. For example, 500 might refer to office occupations, 800 to industrial occupations, and so forth. If further

Interviewer_____ Date_____ Company_____ Type of Data Collection_____ Instrument Version_____	APPROXIMATE NUMBER RECRUITED LAST YEAR	ESTIMATED EMPLOYMENT TREND			NUMBER RECRUITED FROM OUR INSTITUTION	OTHER SOURCES FROM WHICH EMPLOYEES ARE RECRUITED*	
		INCREASING	STABLE	DECREASING			
JOB TITLE							COMMENTS

*CODE FOR OTHER SOURCES FROM WHICH EMPLOYEES ARE RECRUITED. (1) no experience or training, (2) high school graduate, (3) high school graduate with vocational training, (4) other postsecondary institution, (5) B.S. or higher degree, (6) other companies.

Figure 2. BIL needs survey instrument: part 1— employee recruitment data.

Interviewer_____

_____

Date_____

Company_____

Type of Data Collection_____

Instrument Version_____

JOB TITLE	REQUIRED EDUCATION LEVEL (EST. NUMBER OF ANNUAL RECRUITS)			ESTIMATED EMPLOYMENT TREND			COMMENTS
	ASSOCIATE DEGREE	CERTIFICATE (1 YEAR)	SPECIAL COURSES	INCREASING	STABLE	DECREASING	

Figure 3. BIL needs survey instrument: part 2—jobs for which employees would be recruited if the appropriate training were available (less than B.S. degree).

Interviewer_____

_____

Date_____

Company_____

Type of Data Collection_____

Instrument Version_____

TRAINING TOPIC	DESIRED INVOLVEMENT		PREFERRED TIME						
	APPROXIMATE HOURS	APPROXIMATE TOTAL HOURS	AM	NOON	PM	EVENING	SATURDAY	LOCATION PREFERENCE*	COMMENTS

*LOCATION CODE: (1) On Job Site; (2) at Area Facility, (3) On Campus.

Figure 4. BIL needs survey instrument: part 3—employee training needs.

distinction is required, 510 could refer to accounting, 520 to secretarial, and so forth. Each job title listed should be cross-referenced to an instructional unit by placing the appropriate number in parentheses following the job title. This numbering and cross-referencing will allow for easier analysis and distribution of data at the completion of the project.

The term "training topic" as used here refers to the identifying name of the education or training the institution provides to an individual who is *already employed*.

The purpose of identifying training topics is to provide a listing that will be the basis of part 3 of the BIL needs survey instrument (see figure 4). The training topics should not include those normally considered a part of preemployment training, since this portion of the survey deals only with in-service and in-house education needs of employees.

Efforts should be made to include innovative and non-traditional topics in this section. Also, it is assumed that employers will contribute additional topics at the time data is being gathered.

Step 8: Customize Survey Instrument

The next step in the procedure is to develop a "customized" version of the survey instrument for each previously identified occupational area. The BIL survey instrument shown in figures 2, 3, and 4 includes only necessary information without overwhelming employers by requiring large amounts of difficult-to-obtain data. The instrument is divided into three parts. The first part, shown in figure 2, deals with employee recruitment data. The lines under the heading *"job title"* should be completed by adding job titles identified in step 7. *Only those job titles for which the institution is currently preparing people to enter should be listed in Part 1.* A different version of part 1 should be prepared for each different occupational area identified in step 4. Each version of the instrument should be identified by placing a number in the designated place in the upper left corner.

The second part of the survey instrument, shown in figure 3, deals with jobs for which the institution might develop pre-employment training programs if employer needs are substantial. The lines under the heading "job title" must be completed. Typically this listing of job titles will be much shorter than in part 1. There should be *no duplication* of job titles between parts 1 and 2. In both sections, space should be provided for the employer to add job titles to the list.

The third part of the survey instrument shown in figure 4, deals with special courses and training topics that the institution provides for those *already employed*. Once again, the primary difference between part 3 and parts 1 and 2 is that the first two deal only with preemployment training, while part 3 focuses on in-service training for employees. To complete part 3, the team should add the list of training topics developed in step 7 to part 3 of the instrument.

During the process of customizing the instrument, it will be tempting to add other "interesting to know" items. The purpose of this model is to provide a general needs sensing. If an attempt is made to use the system to conduct an occupational analysis either the results will be too superficial to be useful, or the instrument will grow so complex as to be unmanageable.

Step 9: Coordinate Employer Lists and Instruments

At this point the subteams from each area should meet together and review employer lists and customized survey instruments. If different groups have identified the same employer, coordination is required to prevent duplication of effort. Undoubtedly, some of the same job titles or training topics will appear on the different

versions of the instrument. When this occurs, the identification numbers must be adjusted so that whenever a particular job title or training topic is used, it is identified with the same numerical code.

Step 10: Assign Data Collection Responsibilities and Deadlines

Each team member must have a clear understanding of his or her responsibility. Every employer to be surveyed must be assigned to a specific team member. Realistic deadlines for data collection should be established, and the project coordinator will be responsible for seeing that established deadlines are met. This operation is much like a chain in that any single broken link will cause a failure.

Step 11: Duplicate Survey Instruments

Once the coordination of employer lists and survey instruments is complete, the required number of instruments will be duplicated. It may be desirable to color code the various versions or parts of the instrument for ease in application or later processing.

Steps 12/13: Collect Data/Code Data

Each team member should be responsible both for collecting and coding data. There are several reasons for this: (1) to spread the coding task across all team members, (2) to provide team members with opportunities to observe trends and engage in an informal preliminary analyses, and (3) to minimize errors in completing the instruments.

Step 14: Process and Analyze Data

The project coordinator should make arrangements as soon as possible after step 9 for the development of computer programs and coding instructions. It is suggested that preliminary computer runs with dummy data be made and the computer output be reviewed prior to coding and running the data collected.

Step 15: Distribute Processed Data to Instructional Unit Leaders

The numerical cross-referencing of job titles and training topics with instructional units makes it possible to prepare separate data sets for each unit leader (division director, dean, lead instructor, etc.). Providing this "unit specific" data will increase the impact and effectiveness of the project.

Step 16: Make Programmatic Decisions

At this point, the objectives should be reviewed relative to the data collected and the subsequent analysis. This data will support the decision-making process.

Data-Gathering Strategies

There are three basic techniques that can be used to gather data for the BIL needs assessment: the personal interview, the telephone survey, and the mail survey. All three use the BIL survey instrument (see figures 2, 3, and 4) as a basis for gathering the data. Determining which technique should be used will depend on the nature of available resources, type and geographic distribution of employers, and employment patterns for different program areas; however, the personal interview will probably yield the best results.

In the situation, for example, where a small number of large employers absorb the majority of program graduates, the personal interview will be relatively easy to utilize. On the other hand, when program graduates are spread among a large number

of small employers and the employers have few employees, the personal interview may be less feasible and the telephone survey might be most appropriate. The mail survey has been used traditionally to obtain maximum coverage at minimum cost. However, the mail survey frequently eliminates much of the advantage of the BIL needs assessment as a public relations tool.

Any of these techniques, of course, can be used together. For example, a phone interview may precede or follow-up a mail survey. Or, a personal interview may end with a request to complete a survey instrument and return it by mail.

Personal Interview

The personal interview is the most interactive form of data gathering and provides an excellent opportunity for additional public relation activities on behalf of the institution.

It is important to plan the interview to be as time efficient as possible. The interviewer should make it clear at the outset that the BIL survey is not a request for assistance, but that it is a means of determining how the institution can be of greater assistance to BIL. An appointment for the interview will usually be made in advance by phone. If there is a significant time lapse between making the appointment and conducting the interview, a letter confirming the appointment should be sent.

The BIL needs survey instrument provides the core for the interview. If the list of job titles and training topics is longer than can be easily dealt with in an interview, or if some of the data requested are not immediately available, it may be desirable to use the interview to introduce and explain the survey instrument and leave it either to be picked up later or to be returned by mail.

Telephone Survey

The steps in conducting the BIL telephone and/or personal interview are essentially the same as those for conducting the mailed questionnaire. Specific procedures should be developed and tested to conduct this part of the assessment.

Training is important before the interviewer can successfully conduct an interview. Each interviewer should be oriented to the employer needs assessment and trained in interview procedures. In addition, advance practice gives interviewers an opportunity to evaluate and improve their performances. Through practice, interviewers gain insight into handling questions, recording interview data, and identifying some of the problems that may arise.

In placing the telephone call, the interviewer should carefully prepare the respondent. The purpose of the survey should be explained with emphasis on how the respondent will benefit from the survey. In addition, interviewers should be instructed to refer questions they can not answer to designated persons.

Finally, emphasize that personnel officers or other business/industry representatives are typically very busy. Therefore, at the scheduled time of the appointment or call, the interviewer should be prompt and should conduct a brief and effective interview.

Mailed Survey

A common technique used for data gathering is the mailed survey. The BIL needs survey instrument has been designed so that it can be used in a mailed survey with the addition of a cover letter.

A major concern in completing a mailed survey is obtaining a representative response. The following strategies can increase responses.

- *Convenience in responding.* Providing a self-addressed, stamped envelope makes responsing easier. Customizing the list of job titles to minimize the length of the list that apply to each company will shorten the instrument and make it appear easier to complete.

- *The quality of the presentation.* A high-quality, professionally printed survey instrument generates better response.

- *The personal nature of the request.* A "to whom it may concern" letter from "the committee" will probably result in a lower response rate than a personalized letter. A preliminary and/or follow-up phone contact decreases the impersonality of the request, also, and usually increases the response.

- *Incentives and rewards.* Although we might not like to admit it, rewards frequently work. For example, some researchers have included a packet of instant coffee with a message something like "Have a cup of coffee on me!. . . and while you're drinking your coffee, please complete the enclosed survey form." Tickets to an upcoming college event or a pen or pencil stamped with the school name might help increase the return rate.

- *Follow-up.* Following-up either by phone or mail will usually increase the rate of return.

Assessing Program Needs*

A needs assessment can be beneficial to a postsecondary institution in many ways since it usually is part of long-range planning. Because the selection and implementation of products and practices depends on an accurate identification of needs, a thorough needs assessment is the first step in the program improvement process. A needs assessment is also crucial to evaluation, for it helps establish the focus of programs designed to improve the outcomes of the entire educational process. A needs assessment provides data for future planning, as well as a basis for allocation of financial and personnel resources. Moreover, repetitive needs analysis can be used to determine whether or not the program improvement process is working, for example, whether the needs have been met. Such an assessment can be an ongoing activity, can help modify an existing program, and can refocus objectives and content areas. Because educational needs are always changing, assessments must take place regularly.

Most educators are familiar with the definition of an educational need as the difference between an actual situation and a desired state, such as, the difference between "what is" and "what ought to be." This is a discrepancy definition, in that it focuses on the absence of a desired condition. When teachers talk of student needs in terms of some aspect of schooling (such as reading deficiencies), they are using the discrepancy definition of need. However, the problem with this definition is that it assumes knowledge of the perfect state, of "what ought to be." Also, even if we know precisely "what ought to be," we may not be able to obtain it. A better definition of need, therefore, may be the difference between "what is" and "what is satisfactory."

The term *educational needs* often refers to student needs or deficiencies. Many other types of needs exist, for example, program needs, staffing needs, administrative needs, and so on. In a

*Excerpted and adapted from *Problem-Solving Process: A Planner's Handbook for Program Improvement* (Knowle, Smink, and Stark 1982, pp. 8-19).

comprehensive assessment, school staff should consider a whole range of needs. Hence, a needs assessment is a systematic process for determining the difference between existing and desired levels of attainment.

What makes a needs assessment systematic? It is systematic when initial goals are set. Such goals identify "what ought to be" or, more accurately, "what is satisfactory" in student performance, program design, curriculum development, administrative staffing, and so on. Thus, a needs assessment is a process of obtaining and analyzing information about problems related to the established goals (Schriner 1979).

Classification of Needs

There are many types of needs assessments; most involve analyses of perceptions of need, actual data on needs, or a combination of perceptions and actual data. The following classification from Adams, Cohen, Koble (1977) may be helpful:

- *Objective discrepancy analysis.* This technique involves measuring student performance by such objective means as standardized tests and comparing the results to desired status on a set of established goals.

- *Subjective discrepancy analysis.* This technique involves measuring such things as student performance on the basis of the opinions of reference groups (e.g., teachers, parents, and employers).

- *Self-perceived needs discrepancy analysis.* This technique involves assessment of the opinions only of those being evaluated. For example, graduates of a vocational program might be surveyed to determine their perceptions of how the program met their job-training needs.

- *Interactive needs assessment.* This technique involves systematic interaction on the part of educators in a postsecondary institution to generate goals and analyze needs.

- *Objective needs assessment.* This technique involves the analysis of factual data from outside sources such as student achievement test results from a large-scale assessment.

- *Subjective needs assessment.* This technique involves use of a questionnaire or similar instrument to obtain the opinions of respondents on the importance of goals or the seriousness of educational needs.

Each category has its strengths and limitations. Subjective analysis, for example, has the inherent danger of representing the bias of those surveyed. At the same time, overreliance on external data, such as test scores that may not apply to a particular group of students, also can be dangerous. A combination of "hard" or objective data and "soft" or subjective data often will provide the clearest picture of educational needs.

Determine Priorities

A needs assessment can be as simple as an informal survey of student attitudes in a single program or as complex as a nationwide student achievement test. When one does not have resources to perform an extensive assessment, the following steps can be taken to determine priorities for program improvement:

- Identify or develop goals.

- Determine and rate the relative importance of each goal.

- Determine and rate the relative effectiveness of current activities aimed at achieving the goals.

- Identify target areas of need by looking at the difference between "what is satisfactory" and "what is," and by determining the difference between the importance of the goal and the effectiveness of current activities.

- Analyze the current status of the target area to identify more specific needs.

Guidelines for Writing a Needs Statement

One of the barriers to achieving program improvement goals is the lack of specificity in stating the problem. Compare the following two statements:

- "We have a communication problem among our faculty."

- "We use team teaching in our building. Virtually all of us involved in teams are concerned with the fact that we have not given adequate attention to creating ways to share innovative ideas across teams. We need ways of sharing that do not take up the time of those to whom a particular idea is not relevant, but that will share enough detail so those who are interested will know how to try it in their own setting."

The latter is a good "needs" statement because it satisfied three guidelines for writing a good needs statement:

- *Who is affected?* Members of the teaching teams are affected. "Virtually all of us involved in teams are concerned. . . ."

- *What kind of a need is it?* What is lacking is an adequate means for doing something. "We need ways of sharing."

- *What is the goal for improvement*? How will the situation look when the goal has been achieved? In this case, the goal is not simply increased communications. It is the creation of ". . . ways of sharing that do not take time of those to whom a particular idea is not relevant, but that share enough detail so that those who are interested will know how to try it in their own setting."

The most important ingredient is the last item, that is, the specific goal for improvement. However, this guideline is not always easy to formulate. A situation may be complex, may contain any number of major and minor goals, and may take pages to describe. Nevertheless, it must be kept in mind that describing the situation is not the same as writing a needs statement. A needs statement must address the three guidelines and should focus on only one improvement goal in the specific situation.

Needs Assessment Process

Because the needs assessment process appears to be sequential, a number of salient points can be identified. The term used to describe these key items is milestones. The three milestones listed below refer to the critical events that should occur in order to ensure success as an institution progresses through the structured procedures. Each milestone, although of major importance itself, is further broken down into more specific checkpoints or steps. The milestones and steps are described below.

Milestone One: Target Area of Need Is Identified

This milestone is based on the notion that successful program improvement must focus on clearly defined problems.

Step 1: Gather existing data in priority areas.

Step 2: Summarize and analyze data.

Step 3: Prepare a profile that includes all available background data.

Step 4: Conduct first needs assessment meeting of the team. At the meeting, do the following:

- Review data summaries and profiles.
- Have team react to all data.

Step 5: Prepare the general needs statement. This will define the target area to be improved.

Milestone Two: Specific In-depth Needs Are Identified in the Target Area

This milestone is achieved through a comprehensive analysis of the current status efforts in the target area, in order to identify specific needs that are causing problems.

Step 1: Analyze program materials. The analysis should include the following:

- Interest levels
- Variety
- Compatibility with institutional goals in the target area
- Availability
- Quality (Is it up-to-date? Is it comprehensive? Are the reading levels appropriate?)

Step 2: Analyze major elements in the target area using questionnaires, interviews, and observations. Include the following:

- Administration and management
- Staff development
- Student services
- Instructional program

Step 3: Analyze and summarize data from steps 1 and 2.

Milestone Three: A Detailed Needs Summary Is Prepared for the Target Problem Area

This milestone is achieved by reviewing all the data.

Step 1: Prepare the needs assessment summary. Include the following:

- Review of previously summarized materials.
- Review of data summaries on administration and management, staff development, student services, and instructional programs.
- Review of the general needs statement.
- A summary chart for the target area.

Step 2: Provide summary chart to institution's staff. The institution's staff reacts and accepts the summary chart.

After a target area of need has been identified, it is necessary to complete an in-depth assessment in that area. In-depth analyses are completed on program materials, administration and management, staff development, student services, and instructional programs. The assessment team focuses on the following questions:

- Are the current program materials adequate?
- Do teachers, counselors, and students have access to the materials?
- Are the materials compatible with stated program objectives?
- Where are the weaknesses related to the target area in administration and management, staff development, student services, and instructional programs (including student outcomes)?

To answer these questions, items must be written for survey questionnaires and structured interviews. These instruments should have between four and six items for each question. Respondents should be selected from groups with direct involvement in the target area, for example, teachers, administrators, students, counselors, and employers. Usually different forms are constructed for each major group of respondents. The items in each form will ask for similar information but should be phrased differently for each group.

The data collected for each group are summarized and analyzed. When this type of data summary is presented to a planning team, it is organized to show how each group responded. The planning team would then use the data to produce a summary chart that specifies the major problems in the target area that appear to be in need of improvement. This summary is important because the data become the basis for selecting and implementing new products and practices in the target area of need.

Assessing Staff Development Needs*

In order to provide high-quality vocational education in this time of rapidly changing technology, it is imperative that instructors remain up-to-date in the knowledge and skills of their occupational fields. Experience has demonstrated all too clearly that in spite of institutional efforts to provide technological update, staff tend to continue using existing practices and curricula.

As updated curricula are developed and put into place, staff development must be provided if effective instruction is to occur. The process of keeping teachers up-to-date consists of four tasks:

1. Identify the need.
2. Develop a plan of action.
3. Implement the plan of action.
4. Evaluate the implementation of the plan.

As in any effort that aims to instruct, the first essential step in technological update is to identify the exact need for instruction. No program of technological update will be successful if it attempts to deliver instruction that is not perceived by teachers to be needed--that is not relevant. To ensure that instruction offered is needed and relevant, the instruction must take into account the following:

*Excerpted and adapted from *Updating Teachers for Tomorrow's Technology* (Hamilton and Wonacott 1984, pp. 11-14).

- The state of the art in the different technological areas
- Levels of worker competence required by employers
- Teachers' current state of knowledge and skills
- Specific areas in which teachers need updating

Many program planners and implementers have learned the hard way the necessity for identifying teachers' individual needs for update. All too often, programs of update activities for secondary or postsecondary teachers have been planned on the basis of what is available instead of what is needed. Teachers who participate in such activities are usually quick to voice their dissatisfaction with them and with future activities planned as part of the same program. Sitting through an 8-hour workshop on a topic entirely outside one's teaching area or not relevant to one's individual needs is much more likely to discourage further participation than to encourage it. Furthermore, lack of awareness on the part of teachers of the need for update was one of the most frequently reported barriers in a previous investigation (Hamilton, Wonacott, and Simandjuntak 1982, p. 45).

Assess the State of the Art and Levels of Worker Competence Required by Employers

The first factor to be identified is the state of the art in the technologies in question. Specific information must be gathered on the processes, operations, machinery, and equipment in use in the workplace. Also needed is specific information on the levels of competence needed by beginning workers to function in this technological setting. What knowledge and skills do employers require of their beginning workers, given the technology used in local businesses and industries?

There may be, of course, considerable differences between the state of the art of the technology in the workplace and the levels of beginning employee competence needed by employers. As an example, clerical offices of a given employer may represent the very latest in office practices; perhaps all document production is done on word processors--the office might not contain a single conventional typewriter. The employer, however, may or may not want beginning workers that have received specific training in how to operate word processors. The employer may be quite content to have beginning employees who have had basic knowledge of business document format and basic keyboard skills; the employer might prefer to give beginning employees specific instruction in operating the actual office equipment. The same logic applies to different technological areas as well.

It is important to note that information on both the state of the art and levels of employee competence must ultimately come from one source--potential employers in business and industry. The typewriter equipped office setting is irrelevant to the local situation if local businesses and industries are equipped with computers. What teachers really need is precise knowledge of the specifics that their students will encounter in working for employers and the preparation that students will need for those specifics.

Assess Teachers' Current State of Knowledge and Need for Update

The other factor to be identified is the current level of teachers' technological knowledge and skills:

- What technological processes and operations are taught in teacher's programs?
- What equipment and machinery are students taught to use in the classroom or laboratory?

- Are these the same as the processes, operations, equipment, and machinery that students are likely to encounter in the workplace?

- If they are different, what exactly are the differences?

- What knowledge and skills do teachers have that are not reflected in their curricula?

The difference between the knowledge and skills that teachers actually have and those required of them by virtue of the technology in place in the world of work tells program planners and implementers how out of date teachers are. It is important to remember, however, that teachers, whether secondary or postsecondary, may not need to gain all the knowledge and skills required to function in the state-of-the-art technology. The levels of competence that potential employers require of beginning workers is a more precise indicator of the actual updated knowledge and skills that teachers need to acquire. Again, "cutting edge" knowledge and skills may be nice and even appropriate in some cases but what teachers *need* is the specific knowledge and skills that will prepare students for the expectations of the world of work. This is, in fact, the definition of technological currency, which is the goal of technological update programs: the specific technological knowledge and skills that teachers need to prepare their students to perform the tasks expected of beginning workers by potential employers in the area.

Weighing Individual Needs vs. System Needs

Needs identification operates at two levels: the individual teacher and the overall system, whether the system comprises a single institution or multiple institutions making up a postsecondary district. Individual teachers must identify their own specific needs for updated knowledge and skills. This identification forms the basis for their future actions in acquiring update. Individual instructors can then carry out specific activities that will meet their particular needs for updating.

An overall program designed for numbers of instructors, on the other hand, will concentrate on the needs of the system as a whole. If a series of workshops is being planned, for example, the number of teachers who need updating on a particular topic should be considered. A given workshop that would meet the needs of a large number of teachers would be cost effective and therefore appropriate; the same workshop would be inappropriate if it met the needs of only a single teacher or a small number of teachers. For the latter case, a more appropriate system-wide approach would be individual activities (e.g., work experience interships) to meet the needs of the single teacher or small number of teachers.

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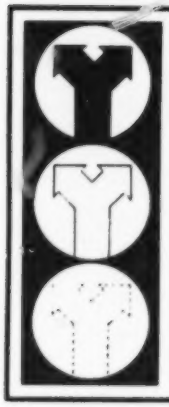

Chapter 4
Defining Objectives

Using Information to Define Program Needs, Goals, and Objectives*

The program needs, goals, and objectives that put into operation an institution's mission for education should be specified. There are at least three kinds of program needs that are typically addressed in planning for education. These are (1) program growth needs, (2) program quality needs, and (3) program support needs (Starr et al. 1978). Labor market information (for example, employment information and labor market experiences of employers and former students) can play an important role in determining the nature and extent of these program needs. Some of the ways in which labor market information can be useful in formulating program growth and program quality needs are described in this section.

Program Growth Needs

Vocational-technical education has continued to receive reasonable financial and political support in part because it has kept its programs and enrollments tuned to the requirements of employers for trained workers and the needs of persons for job skills. There are at least three kinds of data that are useful for determining program growth needs: student interest data, student placement and follow-up data, and employment supply and demand data.

Trends in student placement data can be of great value in determining program growth needs and in validating available data about current needs for workers. Needs for workers can be presumed to exist for those occupations in which students are easily placed. In instances where trends in employment data and placement data are inconsistent (for example, many apparent vacancies but few placements, or the reverse), additional analyses of placement and employment data need to be conducted. The purposes of these analyses are to decide whether the observed low or high placement rates are stable and represent special relationships--typical or atypical--between schools and employers, and whether program growth (for example, new programs, expanded enrollments) is likely to adversely impact on current low or high placement rates.

Trends in student follow-up data also can be of great value in making decisions about program growth needs. Whereas employment data provide an index of the current and future needs for workers, follow-up data tell what actually has

*Excerpted and adapted from *Using Labor Market Information in Vocational Planning* (Starr, Merz, and Zahniser 1982, pp. 41-43).

happened to former students. Follow-up data can provide information about whether students continue to remain in the occupations for which they were trained; stability of employment; employers' perceptions of training; occupational mobility of program completers, both vertically and horizontally; economic returns; which groups of students have the most or least success in employment and in which programs; and other similar information.

Needs for program growth as evidenced by current and anticipated employment data should be balanced against the experiences of students in those occupations for which they were trained. The process of balancing employment data and follow-up data is a complex one. Criteria for decisions about program growth needs that balance employment and placement follow-up data should be based, in part, on the labor market intents for vocational education to which the education agency subscribes.

Evidence of actual or potential student interest is another important source of data for determining program growth needs. Evidence of student interest for vocational education is typically secured from (1) student interest surveys; (2) student dropout data; (3) documented reports from support services personnel (for example, counselors); and (4) applications and/or enrollment reports from public and private vocational education and training agencies and institutions.

Longitudinal data about student interest can provide one indication of the trends in student interest in vocational education. The extent of the trends in student interest can influence decisions about how far to expand programs in terms of number of programs and training stations. These trends can also provide a useful index of the probability that new or expanded programs are likely to attract the numbers of students needed to meet occupational skill shortages.

Program Quality Needs

Identifying program quality needs assumes that there is a consensus as to what is meant by "quality." Often, or perhaps in most instances, this is not the case. There is not yet any general agreement about what features of programs provide quality, or improvements in quality. Also, there is still no general agreement about what kinds of program outcomes shall serve as a basis for distinguishing a quality program from one of lesser quality. The problem of defining quality is made even more complex by the fact that the characteristics that students bring to a program (for example, socioeconomic status, intelligence, motivation, language proficiency) also influence program outcomes and affect attempts to measure quality.

In spite of the many problems that exist in defining program quality, decisions in this area must still be made. There are a number of sources that can help establish a pool of candidate program quality needs. These sources include (1) labor market data showing student satisfaction trends pertaining to the training they received; (2) employer satisfaction with the training provided by vocational education programs; (3) the extent of training-specific or training-related placements; (4) evaluation reports and research findings by academic institutions, program supervisors, fiscal auditors, business and industry persons, the state advisory council for vocational education, and the U.S. Department of Education representatives; and (5) formal and informal comments of lay persons including students, former students, parents, and concerned citizens.

Instructional Program Goals and Objectives

A long-range plan for vocational-technical education should specify the

education agency's best thinking about what should be done within given periods of time to deal with the program needs that have been formulated. This "best thinking" is typically reflected in a plan by a set of statements of instructional program goals and objectives.

Instructional program goals are broad statements that give direction to the resolution of program growth and quality needs. Goals prepared in this manner set the framework for the formulation of process and outcome objectives, which in turn serve as the basis for rational decisions to prioritize expenditures and determine resource allocations and activities.

Once instructional program goals have been established, process and outcome objectives need to be prepared. Program objectives operationally define the directions established by the goal statements. Each specific objective is formulated in response to the general direction of the goal to which it applies. Several objectives may be formulated for a single goal.

Process objectives are operations and activities that are carried out in support of goals. For example, a quality goal of vocational education might be to provide students with up-to-date equipment. A process objective for this goal could be conducting a survey to obtain from employers information about the kinds of equipment that can best impart the skills these employers require. An outcome objective related to this process objective might be as follows: 39 business and office occupations programs will be equipped with word processing equipment in the next 18 months.

Two interrelated problems can sometimes surface when formulating instructional goals and objectives. The first problem is to keep the number of program goals and process and outcome objectives to a manageable number. The second problem is to establish process and outcome objectives that are realistic and can be achieved.

In addition to defining program needs, goals, and objectives, program planners must also establish priorities. The following section describes two evaluation methods that can be used to rank or select from different options.

Methods for Establishing Priorities*

In order to determine which vocational-technical programs to implement, maintain or modify, the program planning committee must identify factors or criteria for selecting among potential occupations. The program planning committee must answer the following question:

> What are the most compelling or critical factors about the needs and characteristics of the population to be served, the labor market, and the educational system that need to be considered when choosing among a number of occupations in which there are demands for labor?

The factors emerge from an analysis of the training problem and training concerns. There is no hard and fast rule about how many factors are enough or too many. The context description of the institutional agency, in large measure, should dictate the number and type of factors to be considered.

Criteria for Prioritizing

Suppose that a postsecondary institution is considering developing a vocational program specifically for skilled machine trades workers who are about to become

*Excerpted and adapted from *Using Labor Market Information in Vocational Planning* (Starr, Merz, and Zahniser 1982, pp. 44-54).

involuntarily displaced. The postsecondary institution is concerned with providing these displaced workers with a program that can enable them to make the best of their current machine trades skills, if at all possible.

Given the employment needs and the characteristics of the displaced workers the following eight factors (criteria) appear (for illustrative purposes) to be appropriate:

1. Net openings for workers in each occupation
2. Growth prospects for the occupations
3. Wage levels in the occupations
4. Placement rates of programs preparing persons to secure employment in these occupations
5. Start-up costs for training
6. Ongoing costs for training
7. Restrictive hiring practices by industries with job openings (for example, age, internal bidding arrangements)
8. Location of potential employment opportunities

Of course fewer, other, or additional factors could have been chosen. It is desirable, therefore, to formulate a rationale to explain why certain factors were chosen and others were not.

For example, in this situation wages was selected as an important factor to consider in selecting among occupations because the displaced workers, as a group, represent experienced workers who find it economically difficult to accept minimal wages. Another factor, growth prospect, was included because it is important for displaced workers to avoid occupations in which the numbers of persons employed are declining since this situation could lead to a second traumatic displacement.

One factor sometimes considered in selecting among occupations is that of the environmental conditions of work (for example, indoor, outdoor, noise levels, and so forth). This factor was not chosen in the example because it probably would not significantly influence the acceptability of another occupational placement by most of the displaced workers.

Applying the Factors

Once the factors (criteria) against which the occupations will be rated have been chosen, there are different evaluation methods that can be used to rank or select the particular occupation(s) for planning programs. Two evaluation methods that can be used to select occupations most appropriate for inclusion in instructional program planning include the fatal flaw analysis method, and the feature analysis method.

The Fatal Flaw Analysis Method

This method is useful when there is a short timeframe. It also can be used when the factors against which occupations are to be evaluated are essentially independent and have great discriminatory value. In general, implementation of the fatal flaw analysis method takes the following form:

- Establish criteria (factors in our example).
- Determine the discriminatory value for each criterion.
- Establish candidates (occupations in our example) against which to apply the valued criteria.
- Determine "winner(s)" (occupation(s) that meet all or the greatest number of valued criteria).

If too many "winners" exist, then either more discriminators (factors) need to be developed, or the discriminatory values assigned to each of the criteria might need to be made more stringent.

Tables 2 and 3 depict the application of the fatal flaw evaluation method for selecting among a number of occupations the one(s) most appropriate for displaced worker retraining. This example uses 19 occupations and the 8 factors (criteria) listed above.

The Feature Analysis Method

An evaluation method that can be used by itself or in conjunction with the fatal flaw analysis method is called the feature analysis method. In this method the factors are first assigned raw scores. The scores are normalized; weighting factors are applied as needed, and then the normalized scores are multiplied by any weighting factors that have been assigned. The normalized and weighted scores for each factor are finally added together to determine the occupation with the highest score. Although the feature analysis method is a very appropriate one for selecting among occupations for program planning purposes, it can be quite complex and time-consuming to implement.

The fatal flaw analysis and feature analysis evaluation methods are useful because they provide a means to objectify (make explicit) the bases upon which occupations are selected for instructional planning purposes. Explicitly defining the factors against which occupations are ranked and rated does not, of course, guarantee that the best factors were chosen or that the measures of discrimination and weighting given to each factor were the correct ones. Nevertheless, these kinds of evaluation methods provide a rational,

TABLE 2

SELECTING OCCUPATIONS BY THE FATAL FLAW ANALYSIS TECHNIQUE —CRITERIA AND DISCRIMINATORY VALUES—

Criteria	Value If:
1. Net openings for workers in each occupation	More than 50 average annual openings per year
2. Growth trends in net job openings	Positive and in top 20 in SMSA in rate of growth
3. Wages	Average or above for manufacturing occupations in SMSA
4. Placement rate	Greater than 80%
5. Start-up costs for training	Less than $16,000
6. Ongoing costs for training	Less than $4,000
7. Restrictions on hiring	No pattern based on personal attributes of job seekers
8. Location of employment	Within 35-mile radius of Resort City itself

TABLE 3

SELECTING OCCUPATIONS BY THE FATAL FLAW ANALYSIS TECHNIQUE —EXAMINING CANDIDATE OCCUPATIONS AND SELECTION WINNER(S)—

	Criteria								
Occupations	Net Openings	Growth	Wages	Place-ment	Start-up Costs	Ongoing C[illegible]	Hiring Restric-tions	Location of Jobs	Winners
Secretaries	x	x	x	x	x	x	x	x	1. Secretaries*
Sales Workers	x	—	—	—	x	x	x	x	
Waiters/Waitresses	x	—	—	—	x	x	x	x	
Cashiers	x	—	—	—	x	x	x	x	
Bookkeepers	x	—	—	—	x	x	x	—	
Truck Drivers	x	—	x	—	—	—	—	—	
Typists	x	—	—	x	x	x	x	x	
Cooks	x	—	—	—	—	x	—	—	
Assemblers (N/A)									
Machine Operators	x	—	—	—	x	x	x	—	
Checkers/Examiners (N/A)									
Packers/Wrappers (N/A)									
Heavy Equipment Mechanics		—	x	x	x	x	x	x	
LPNs	—	x	—	—	—	—	—	—	
Guards(N/A)									
Delivery Route Workers (N/A)									
Auto Mechanics	—	—	x	x	—	x	—	x	
Receptionists	—	—	—	—	x	x	x	x	
Carpenters	x	—	x	—	x	x	x	x	

*If all eight factors must be valued. If seven valued factors are acceptable, then heavy equipment operators and carpenters would also be "winners."

systematic, and defensible means for making choices among occupations.

Applying Both Methods

Using both evaluation methods, the occupation of secretary ranks as the most appropriate for providing training to the displaced machine trades workers. Heavy equipment operator was also highly ranked. If one or both of these occupations appear to be inappropriate to the agency or to the displaced workers, two conclusions can be drawn: (1) the factors or their measures need to be revised; or (2) there are no occupations that are suitable for retraining the displaced workers, and the agency might want to consider if it should focus its energies on providing job search skills training or placement assistance through its craft and advisory committee structure.

Indeed, it could be argued that the best factors were not chosen. For example, the factors of "skills transferability" and "training time" are important ones in this case but are not included in the list of eight factors. In the case of the displaced workers, it is highly important for them to enter occupations in which they can transfer their existing skills so that they can retain as closely as possible the status and economic rewards of being a skilled worker. Also, because of the economic hardships many displaced workers must endure, training time becomes a significant consideration. The shorter the training time, the sooner the displaced worker can be back at work.

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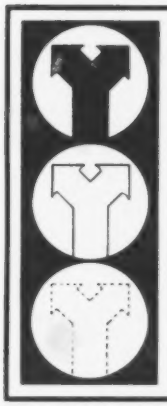

Chapter 5
Identifying Resources

Information Resources for Vocational-Technical Education*

The best information resource is often the most accessible one. Information resources such as professional journals, popular periodicals, and professional contacts can provide valuable information. However, when these sources have been exhausted, additional sources are available. These sources can help to ensure that any search for information is comprehensive and up-to-date.

Information Systems and Networks

A variety of information systems and networks are available to curriculum developers. A brief description of some of these follows.

Educational Resources Information Center (ERIC)

Educators have ready access to one of the most comprehensive collections of materials available in the social sciences. The Educational Resources Information Center (ERIC) system contains a wide variety of materials, including curricula, handbooks, speeches, and reports. Many of these materials cannot be easily obtained from any source other than ERIC.

Materials included in ERIC are available in microfiche collections in 630 locations across the country. These collections are updated regularly. Any library with an ERIC microfiche collection permits users to read or copy documents by using a microfiche reader or reader-printer.

All items in the ERIC collection are indexed in either *Resources in Education* (RIE) or *Current Index to Journals in Education* (CIJE), both published monthly. RIE documents are any print material (including curricula, research reports, and conference presentations) other than journal articles. Documents in RIE are listed by ED number and indexed by subject, author, institutional source, and publication type. Document abstracts are printed in the resume section of every RIE issue. CIJE is an index to the articles published in more than 775 educational journals. Articles in CIJE are listed by EJ number and indexed by subject, author, or journal title. Abstracts also appear in the resume section.

One of the best ways to locate information in a short period of time is to contact one or more of the 16 ERIC clearinghouses. The clearinghouses are major components of the ERIC system, and each

*Excerpted and adapted from *Using Information Resources to Help Improve Vocational Education Programs* (Norton et al. 1983, pp. 25-47) and *Direct Curriculum Development* (Norton et al. 1983, pp. 17-19).

clearinghouse covers an area of specialty within education.

The ERIC clearinghouses have responsibility within the network for acquiring the significant educational literature within their particular areas, selecting the highest quality and most relevant material, processing (i.e., cataloging, indexing, abstracting) the selected items for input to the data base, and also for providing information analysis products and various user services based on the database.

There are currently 16 clearinghouses. These are listed below, together with addresses and brief scope notes describing the areas they cover.

- ERIC Clearinghouse on *Adult, Career, and Vocational Education* (CE)
  The Ohio State University
  The National Center for Research in Vocational Education
  1960 Kenny Road
  Columbus, Ohio 43210

  All levels and settings of adult and continuing, career, and vocational-technical education. Adult education, from basic literacy training through professional skill upgrading. Career education, including career awareness, career decision making, career development, career change, and experience-based education. Vocational and technical education, including new subprofessional fields, industrial arts, corrections education, employment and training programs, youth employment, work experience programs, education/business partnerships, entrepreneurship, adult retraining, and vocational rehabilitation for the handicapped.

- ERIC Clearinghouse on *Counseling and Personnel Services* (CG)
  University of Michigan
  School of Education, Room 2108
  610 East University Street
  Ann Arbor, Michigan 48109

  Preparation, practice, and supervision of counselors at all educational levels and in all settings; theoretical development of counseling and guidance; personnel procedures such as testing and interviewing and the analysis and dissemination of the resultant information; group work and case work; nature of pupil, student, and adult characteristics; personnel workers and their relation to career planning, family consultations, and student orientation activities.

- ERIC Clearinghouse on *Educational Management* (EA)
  University of Oregon
  1787 Agate Street
  Eugene, Oregon 97403

  The leadership, management, and structure of public and private educational organizations; practice and theory of administration; preservice and inservice preparation of administrators; tasks and processes of administration; methods and varieties of organization and organizational change; and the social context of educational organizations.

  Sites, building, and equipment for education; planning, financing, constructing, renovating, equipping, maintaining, operating, insuring, utilizing, and evaluating educational facilities.

- ERIC Clearinghouse on *Elementary and Early Childhood Education* (PS)
  University of Illinois
  College of Education
  805 W. Pennsylvania Avenue
  Urbana, Illinois 61801

  The physical, cognitive, social, educational, and cultural development of children from birth through early adolescence; prenatal factors; parental behavior factors; learning theory research and practice related

to the development of young children, including the preparation of teachers for this educational level; educational programs and community services for children; and theoretical and philosophical issues pertaining to children's development and education.

- ERIC Clearinghouse on *Handicapped and Gifted Children* (EC)
  Council for Exceptional Children
  1920 Association Drive
  Reston, Virginia 22091

  All aspects of the education and development of the handicapped and gifted, including prevention, identification and assessment, intervention, and enrichment, both in special settings and within the mainstream.

- ERIC Clearinghouse on *Higher Education* (HE)
  George Washington University
  One Dupont Circle, N.W., Suite 630
  Washington, D.C. 22036

  Topics relating to college and university conditions, problems, programs, and students. Curricular and instructional programs, and institutional research at the college or university level. Federal programs, professional education (medicine, law, etc.), professional continuing education, collegiate computer-assisted learning and management, graduate education, university extension programs, teaching-learning, legal issues and legislation, planning, governance, finance, evaluation, interinstitutional arrangements, management of institutions of higher education, and business or industry educational programs leading to a degree.

- ERIC Clearinghouse on *Information Resources* (IR)
  Syracuse University
  School of Education
  Huntington Hall, Room 030
  150 Marshall Street
  Syracuse, New York 13210

  Educational technology and library and information science at all levels. Instructional design, development, and evaluation are the emphases within educational technology, along with the media of educational communication; computers and microcomputers, telecommunications (cable, broadcast, satellite), audio and video recordings, film and other audiovisual materials, as they pertain to teaching and learning. Within library and information science the focus is on the operation and management of information services for education-related organizations. All aspects of information technology related to education are considered within the scope.

- ERIC Clearinghouse for *Junior Colleges* (JC)
  University of California at Los Angeles (UCLA)
  Mathematical Sciences Building
  Room 8118
  405 Hilgard Avenue
  Los Angeles, California 90024

  Development, administration, and evaluation of two-year public and private community and junior colleges, technical institutes, and 2-year branch university campuses. Two-year college students, faculty, staff, curricula, programs, support services, libraries, and community services. Linkages between 2-year colleges and business/industrial organizations. Articulation of 2-year colleges with secondary and 4-year postsecondary institutions.

- ERIC Clearinghouse on *Languages and Linguistics* (FL)
  Center for Applied Linguistics
  1118 22nd Street, N.W.
  Washington, D.C. 20037

  Languages and language sciences; theoretical and applied linguistics; all areas of foreign language, second language, and linguistics instruction, pedogogy, or methodology; psycholinguistics and the psychology of language learning; cultural and intercultural context of languages; application of linguistics in language teaching; bilingualism and bilingual education; sociolinguistics; study abroad and international exchanges; teacher training and qualifications specific to the teaching of foreign languages and second languages; commonly and uncommonly taught languages, including English as a second language; related curriculum developments and problems.

- ERIC Clearinghouse on *Reading and Communication Skills* (CS)
  National Council of Teachers of English
  1111 Kenyon Road
  Urbana, Illinois 61801

  Reading, English, and communication skills (verbal and nonverbal), preschool through college; educational research and instruction development in reading, writing, speaking, and listening; identification, diagnosis, and remediation of reading problems; speech communication (including forensics), mass communication, interpersonal and small group interaction, interpretation, rhetorical and communication theory, speech sciences, and theater. Preparation of instructional staff and related personnel in these areas.

  All aspects of reading behavior with emphasis on physiology, psychology, sociology, and teaching; instructional materials, curricula, tests/measurement, and methodology at all levels of reading; the role of libraries and other agencies in fostering and guiding reading; diagnostics and remedial reading services in schools and clinical settings. Preparation of reading teachers and specialists.

- ERIC Clearinghouse on *Rural Education and Small Schools* (RC)
  New Mexico State University
  Computer Center (Room 218),
  Stewart Street
  Box 3AP
  Las Cruces, New Mexico 88003

  Economic, cultural, social, or other factors related to educational programs and practices for rural residents; American Indians/Alaska Natives, Mexican Americans, and migrants; educational practices and programs in all small schools; outdoor education.

- ERIC Clearinghouse for *Science, Mathematics, and Environmental Education* (SE)
  The Ohio State University
  1200 Chambers Road, Room 310
  Columbus, Ohio 43212

  Science, mathematics, and environmental education at all levels, and within these three broad subject areas, the following topics: development of curriculum and instructional materials; teachers and teacher education; learning theory/outcomes (including the impact of parameters such as interest level, intelligence, values, and concept development upon learning in these fields); educational programs; research and evaluative studies; media applications; computer applications.

- ERIC Clearinghouse for *Social Studies/Social Science Education* (SO)

Indiana University
Social Studies Development Center
2805 East 10th Street
Bloomington, Indiana 47405

All levels of social studies and social science education; content of the social science disciplines; applications of theory and research to social science education; contributions of social science disciplines (anthropology, economics, geography, history, sociology, social psychology, political science); education as a social science; comparative education (K-12); content and curriculum materials on "social" topics such as law-related education, ethnic studies, bias and discrimination, aging, adoption, women's equity, and sex education.

- ERIC Clearinghouse on *Teacher Education* (SP)
  American Association of Colleges for Teacher Education
  One Dupont Circle, N.W., Suite 610
  Washington, D.C. 20036

  School personnel at all levels; teacher selection and training, preservice and inservice preparation, and retirement; the theory, philosophy, and practice of teaching; curricula and general education not specifically covered by other clearinghouses; all aspects of physical education, health education, and recreation education.

- ERIC Clearinghouse on *Tests, Measurement, and Evaluation* (TM)
  Educational Testing Service
  Rosedale Road
  Princeton, New Jersey 08541

  Tests and other measurement devices; methodology of measurement and evaluation; application of tests, measurement, or evaluation in educational projects or programs; research design and methodology in the area of testing and measurement/evaluation; learning theory in general.

- ERIC Clearinghouse on *Urban Education* (UD)
  Teachers College, Columbia University
  Institute for Urban and Minority Education
  Box 40
  525 W. 120th Street
  New York, New York 10027

  Programs and practices in public, parochial, and private schools in urban areas and the education of particular racial/ethnic minority children and youth in various settings--local, national, and international; the theory and practice of educational equity; urban and minority experiences; and urban and minority social institutions and services.

A search analyst is a valuable aid in carrying out a computer-assisted search of ERIC (and other databases as required). Computer searching not only saves time but also makes available the expertise of an analyst familiar with the content of the database. A more complex and well-defined search is possible via computer, because several terms or descriptors drawn from the *Thesaurus of ERIC Descriptors* can be combined in searching for relevant documents. A computer search also automatically provides a bibliography or reference list. Furthermore, the search can be limited to specific types of documents as well as specific years. Finally, a computer search is more comprehensive, because the computer can search for terms that appear in the title and the abstract, as well as all assigned terms in the subject index.

Computer search facilities are located in over 500 institutions or agencies nationwide. If a facility is not available in your particular geographic area, a computer search can also be arranged by phoning the ERIC Clearinghouse that specializes in the topic of concern.

Dissemination Networks: Information Resources for Education (1978)

Developed by the Far West Laboratory for Education Research and Development, this document describes networks in specific areas of education. It includes the following information on each network listed: major functions, network members, target audience, description, available information, contractors, and date established. A contact person is listed for each network. Many times, you can contact the nearest representative of a network specializing in your topic of concern and be directed to appropriate materials, organizations, or experts. This publication can be ordered from Educational Resource Center, 855 Broadway, Boulder, Colorado 80302. It is also available through ERIC (ED 162 633).

National Network for Curriculum Coordination in Vocational and Technical Education (NNCCVTE)

This network, funded by the U.S. Department of Education, consists of six regional curriculum coordination centers with liaison representatives in each state and territory. The major function of the network is to provide information, instructional materials, inservice training, and technical assistance to help states improve their curriculum development and management practices in vocational and technical education. The centers emphasize the adaptation or adoption of federal, state, or locally developed materials to conserve resources and improve states' capabilities in curriculum development. The six regional centers and the states they serve are listed below.

- *Northeast Curriculum Coordination Center*

  States and territories served:
  Virgin Islands, Puerto Rico, Rhode Island, Vermont, New Jersey, Connecticut, Maine, Massachusetts, New Hampshire, New York

  Rutgers University
  200 Old Matawan Road
  Old Bridge, NJ 08857

- *Southeastern Curriculum Coordination Center*

  States served:
  Tennessee, Mississippi, Florida, Georgia, North Carolina, Kentucky, South Carolina, Alabama

  Mississippi State University
  Research and Curriculum Unit
  Drawer DX
  Mississippi State, MS 39762

- *East Central Network Illinois Vocational Curriculum Center*

  States served:
  Illinois, Delaware, Pennsylvania, Minnesota, Indiana, West Virginia, Virginia, Maryland, Ohio, Wisconsin, Michigan, District of Columbia

  ECN/IVCC
  Sangamon State University
  Springfield, IL 62708

- *Midwest Curriculum Coordination Center*

  States served:
  Oklahoma, Arkansas, Texas, Kansas, Missouri, Nebraska, New Mexico, Iowa, Louisiana

  State Department of Vocational and Technical Education
  1500 West Seventh Avenue
  Stillwater, OK 74074

- *Northwest Curriculum Coordination Center*

  States served:
  Washington, Alaska, Colorado, Idaho, Montana, North Dakota, South Dakota, Oregon, Utah, Wyoming

Saint Martin's College
Old Main Building, Room 474
Lacey, WA 98503

- *Western Curriculum Coordination Center*

States and territories served:
California, Arizona, Hawaii, Nevada, American Samoa, Guam, Trust Territory of Pacific Islands

University of Hawaii at Manoa
College of Education
1776 University Avenue
Honolulu, HI 96822

National Diffusion Network (NDN)

The National Diffusion Network (NDN) is a federally funded system that makes exemplary educational programs available for adoption by schools, colleges and other institutions.

NDN facilitates program adoption by providing dissemination funds to exemplary programs, called Developer Demonstrator projects, for two purposes: (1) to make public and nonpublic schools, colleges and other institutions aware of what they offer, and (2) to provide training, materials and follow-up assistance to schools and others that want to adopt them.

NDN also provides funds to State Facilitators, who serve as matchmakers between NDN programs and schools and organizations that could benefit from adopting the programs. NDN Facilitators are based in local school districts, intermediate service agencies, state education agencies, and private nonprofit organizations. To obtain more information about NDN, contact your state department of education.

Vocational Education Curriculum Materials (VECM) Database

The Vocational Education Curriculum Materials (VECM) database is a comprehensive, centralized, computerized database of information on curriculum materials. Only current vocational and technical curriculum materials (including military curriculum) that have national availability are entered into VECM. Over 5,000 records of both print and nonprint materials (including over 900 microcomputer courseware entries) are now in the database and the number is continually increasing. All curriculum materials entered on the VECM database must meet the following standards:

- Be a vocational or technical curriculum product (material used by teachers/students in the teaching/learning process)
- Have a nationwide availability source
- Have a 1978 or more recent development or publication date
- Be either print or nonprint form
- Be a public domain product, except for microcomputer courseware

Each VECM entry includes the following information about the curriculum product: title, date, sponsoring agency, developer, subject matter classification, educational level, intended user, student target population, description of the print or nonprint materials, copyright restrictions, and availability source.

The curriculum coordination centers of the National Center continue to build and maintain the VECM database. All vocational and technical educators are encouraged to

enter information about curriculum materials into the databases. Contact either your CCC or the National Center for assistance in entering or retrieving VECM information.

National Center Clearinghouse Program Improvement Database

The Program Improvement Database, produced by the National Center Clearinghouse, goes by the search label of RIVE, which stands for Resources in Vocational Education. The data base contains descriptions of vocational education projects in two categories. The first category includes ongoing and recently completed research and development projects, exemplary and innovative projects administered through state research coordinating units. The second category includes federally administered projects related to career education, vocational education, and education and work. The National Center Clearinghouse acquires project proposals or summaries from states and selected federal agencies for input into the database.

The database uses ERIC descriptors for online subject searching and includes names of project directors, organizations performing the work, funding information, and availability of reports and products resulting from completed projects.

Information Products

Many organizations produce materials that can be valuable information sources. The National Center for Research in Vocational Education, state curriculum laboratories, and regional consortiums are examples of some of these organizations.

The National Center for Research in Vocational Education

This organization regularly develops resources for vocational administrators. The following are categories of informational product types from the National Center. They cover a range from research review and synthesis papers to handbooks and practical guides.

Original research reports. These reports usually present the theoretical base, methodology, findings, conclusions, and recommendations of a study, analysis, or evaluation conducted to provide answers to research questions. Researchers are the primary audience for such reports, although administrators doing extensive work in a problem area might refer to the findings and conclusions of such a report.

The development of a research review and synthesis paper. This process begins with a review of all the literature representing the "state of the art" on a selected topic. Once reviewed, that literature is examined in a new way to identify a pattern, concept, or structure not previously evident. The review and synthesis paper "make sense" of the literature on a topic, providing new information by synthesizing what exists. Most review and synthesis papers are intended for scholars, researchers, and other specialists, although vocational administrators and teachers may use them for a comprehensive understanding of a topic.

Interpretations or analyses of research reports. Such products for a nonresearch audience clarify or explain the meaning of research findings. Typical audiences include decision makers, teachers, and persons without a specialized background in a topic.

Practical applications of research findings. These are put into handbooks, guides, curricular materials, audiovisuals, and how-to products for decision makers, administrators, or classroom teachers. The terms *development and research and development* usually refer to the production of such materials.

Summaries, abstracts, annotations, and bibliographies. These are designed as

fact sheets or reference sources for any audience, including both researchers and practitioners. Such information products usually provide only enough information to allow individuals to decide whether additional information or the full text of a document should be consulted. Executive summaries, however, give busy decision makers a quick overview of the central concepts in an important topic or report, without requiring additional reading.

State Curriculum Laboratories

Many states have one or more curriculum laboratories or instructional materials centers that are supported through state department of education funding and/or through membership subscription fees. Some states have separate labs for agricultural education, distributive education, and trade and industrial education, while other states have only one lab or center serving all vocational education service areas. Many of these curriculum labs and centers have developed and published occupational (task) analyses. The Ohio State University's Trade and Industrial Education Instructional Materials Laboratory, for example, has released analyses for over 100 occupational areas.

A number of states have developed a centralized approach to curriculum development that results in a standard, base, or core curriculum that is recommended for use by the institutions in that state. Before beginning a local curriculum development effort, it is advisable to check the status of existing state or regional efforts.

Regional Consortiums

In recent years a number of regional consortiums have been organized and supported by various states and/or individual institutions to fund the development of occupational analyses and/or curriculum materials. Three such consortiums are as follows:

- *Vocational-Technical Education Consortium of States (V-TECS)* is a consortium of some 14 states (mostly in the Southeast) joined together to conduct occupational analyses and to publish them in the form of catalogs. An occupational catalog consists of the duty areas, task statements, learning guides, and criterion-referenced measures for each task. Over 100 catalogs can be obtained (if your state is a member of V-TECS) from your state department of education. Nonmember states can purchase the catalogs from Curriculum Publications Clearinghouse; Western Illinois University; Horrabin Hall 46; Macomb, Illinois 61455.

- *Interstate Distributive Education Curriculum Consortium (IDECC)* is a consortium of states that started in 1972 to develop a competency-based learning system based on task analysis for 69 occupations in marketing and distribution. The consortium sponsored the development of 1,500 learning activity packages (LAPs), containing 983 competencies and over 2,000 behavioral objectives, and is continuing to develop more competencies based on occupational analyses for additional occupations. The IDECC office is located at The Ohio State University; 1564 West First Avenue; Columbus, Ohio 43212.

- *Mid-America Vocational Curriculum Consortium (MAVCC)* is a consortium of 11 states that produces vocational instructional materials in a wide range of occupational areas. The format of the materials is uniform throughout and has been designed to satisfy the needs of all member states. Each curriculum manual has a teacher edition. The materials are available to member states (at special prices) and nonmember states from Mid-America Vocational Curriculum Consortium, Inc.; 1515 West Sixth Avenue; Stillwater, Oklahoma 74074.

In addition, within your own individual state, certain occupational analyses may have been developed in a particular school district, university, professional and technical association, labor organization, potential employer, federal or state government bureau, manufacturer's association, business or commerce institution, research or consulting firm, etc.

The human resources of an institution are often the best source of ideas or alternatives for the curriculum development effort. By using special small-group techniques, an administrator can draw upon the experiences and knowledge of the institution's human resources--other administrators, staff members, and students. Working in a small-group setting, an administrator can gather information and shape the information into a vehicle for change. Three small-group techniques that can be used for gathering information to help make better decisions are discussed in the following section.

Using Small-Group Techniques for Gathering Information*

The first technique described is the *nominal group technique*. This is a technique for generating ideas that occur in a structured group setting. The second technique is called *brainstorming*. This is a less formal technique than the nominal group technique, and one that works given a shorter period of time for idea generation. The third techniques is called *force field analysis*. Force field analysis is a technique used to identify the positive and negative implications of any given decision. This technique can be used individually as well as with a group.

The Nominal Group Technique

The nominal group technique (NGT) is generally limited to single-purpose, single-topic meetings. It can be useful in a variety of situations:

- Working with an advisory committee to identify funding sources for some new equipment that is not covered by your regular budget
- Setting priorities for the content of a new curriculum
- Seeking ways to integrate occupational exploration into existing vocational courses

NGT is used to generate high-quality alternatives or ideas for use as solutions to a given problem. The approach is highly structured and works well with an issue that is clearly defined. NGT has a prescribed sequence of problem-solving steps that must be followed. This technique was designed to minimize group pressure or value judgments that might inhibit the productive and creative generation of ideas. The person or persons initiating this technique serve as the leaders since they have the most knowledge about the problem and the technique.

NGT works best with groups that have at least five members and not more than nine. The designers of this technique recommend this group size for several reasons. First of all, groups that have less than five members usually lack the resources necessary to generate adequate and accurate problem solutions. Second, interaction studies indicate that groups that range from five to seven members have

*Excerpted and adapted from *Use Inquiry Skills to Help Improve Vocational Education Programs* (Norton et al. 1983, pp. 57-67).

the most success at staying on task and functioning as a group.

NGT can be used successfully by a larger group if it is subdivided into smaller groups of five to nine members. The process steps are the same, except a step is inserted for the combining of small-group results.

NGT can be used in time blocks of from 2 hours to 1 day in length. The amount of time required varies with the number of participants and the complexity of the problem being addressed. The group leader will also need to plan time for completing preliminary steps such as selecting and preparing the meeting room, providing the supplies needed, and presenting the opening statement. The NGT process can be summarized in the following six steps.

Step 1: The Silent Generation of Ideas in Writing

This step involves the following activities:

- Present the nominal question to the group in writing.
- Read the question orally.
- Illustrate the level of abstraction and scope desired.
- Avoid other requests for clarification.
- Ask group members to write ideas in brief phases or statements.
- Ask group members to work silently and independently.
- Model good group behavior.
- Discourage disruption of the silent, independent activity by comments addressed to the group as a whole.

Step 2: Round-robin Recording of Ideas

This step involves providing clear instructions to the group about the activities that they will be completing:

- Explain that group members must decide if items are duplicates.
- Explain that an individual may "pass" when he/she has no further items, but may reenter later.
- Express the desirability of "hitch-hiking" on ideas and adding new ideas even if they are not on the work sheets completed individually in step 1.
- Explain the inappropriateness of engaging in discussion prior to the completion of the listing.
- Explain that the objective of the step is to map the group's thinking.
- Explain the need to present ideas in brief words or phases.
- Explain the process of taking one idea, in turn, from each member.
- Record ideas as rapidly as possible.
- Record ideas in the words used by group members.
- Provide assistance in abbreviating ideas only in special situations.
- Make the entire list of ideas visible to the total group.

Step 3: Serial Discussion for Clarification

This step involves the following activities:

- Orally define the purpose of the step so as to clarify the meaning of items and to explain reasons for agreement or disagreement.
- Indicate that final judgments will be expressed by voting.
- Pace the group so that all ideas receive sufficient time for clarification.
- Avoid forcing the member who originally listed the idea to be solely responsible for clarifying the item.

Step 4: Preliminary Vote on Item Importance

This step involves asking the group to select, from the entire list, a specific number of important or priority items. This would include the following activities:

- Ask each group member to select and write five priority items on separate 3" x 5" cards.
- Ask each group member to individually rank-order or rate the priority items.
- Collect the cards and shuffle them to retain anonymity.
- Tally the vote and record the results in front of the group.

Step 5: Discussion of the Preliminary Vote

This step involves the following activities:

- Define the role of the step as one of clarification, not pressure toward an artificial consensus.
- Keep the discussion brief.
- Caution group members to think carefully about any changes they make in their voting.

Step 6: Final Vote

This step is similar to step 4.

- Prepare a list of priority items to display to the group.
- Repeat the voting process used in step 4; emphasize that it will be the final vote.

Brainstorming

Brainstorming is a technique used to stimulate thinking and promote the involvement of participants in discussions. It takes less time than the nominal group technique. Brainstorming might be used to initiate discussions about many diverse topics such as the following:

- How to recruit more males for courses that traditionally have attracted only female students
- How to spend an unexpected $2,000 gift to a department
- How to gain more community involvement in the planning and evaluation of curriculum

Brainstorming often is used as a planning or preplanning activity, but it also can be used as a simple problem-solving technique. The brainstorming session should be guided by a leader, either self- or group-appointed. This technique is most effective when the group is not too large. Generally, a group containing a maximum of 12 people is large enough to generate many ideas and yet small enough to be a working group in which all members are able to actively participate.

Usually, 15-20 minutes is sufficient time to conduct a brainstorming session.

The time may vary depending upon the difficulty of the subject, the number of individuals in the group, and the enthusiasm of group members. Some time should be spent before the session to clarify why the brainstorming session is being conducted and what specific issue is being dealt with.

This process is most effective when carried out in the following structured steps.

Step 1: Choose the Topic of Concern

Identify the topic or concern and state it in specific terms. This will help keep participant's ideas or suggestions from covering too broad an area. In addition, be sure that the topic can be easily understood by participants and that they will have the ability and interest to deal with it effectively. Whatever topic is chosen, it should be carefully described before the session begins.

Step 2: Choose the Leader and Recorder

The brainstorming session should be guided by a leader. The leader has the responsibility for monitoring the actual brainstorming session. The leader should stay in the background as much as possible but should interject ideas to stimulate thinking and keep the responses coming. This person must take care that negative or evaluative phrases are kept to a minimum.

A recorder--who can be selected by the participants--is also needed. This individual has an important and active role in keeping a written record of all suggestions made during the brainstorming session. The suggestions are usually recorded on a chalkboard or flip chart so that all can see them and so that memory won't have to be relied on when the evaluation process begins at a later time.

Step 3: Orient Participants

It is the leader's responsibility to help participants understand that evaluation and criticism are *not* allowed during brainstorming. The assessment of ideas is done at a later time. All ideas related to the topic should be welcomed. Having a variety of alternative suggestions will help to generate more effective plans of action. Because a quantity of varied suggestions is desired, participants should be asked to give spontaneous responses without weighing their value at that time.

Step 4: Generate Ideas

The leader should try to get the group to be spontaneous and to generate ideas quickly. The recorder must take care that all ideas are recorded fully.

Step 5: Close the Session

A closing time should have been arranged before the brainstorming session was begun. At the closing of the session, the leader should ask the recorder to report orally on the suggestions. A written report also should be submitted at a later time.

Step 6: Conduct a Follow-up

The ideas generated in a brainstorming session are just that, a list of ideas. To allow participants to evaluate the ideas generated, it is helpful to hold a session for this purpose after the brainstorming results have been summarized. Brainstorming is best used for idea generation; it should not be viewed as an end, but rather a beginning--a way to stimulate participation and generate a range of ideas and solutions.

Force Field Analysis

Force field analysis is a technique that identifies the positive and negative forces that may influence actions or decisions. This technique is best used by a small group and is effectively used as a planning device as well as an evaluation technique.

Force field analysis can be done alone, but used as a small-group technique, it works best with a group of three to five people. The people should feel comfortable with one another and not be overly concerned with group relationships. This should be a group that is very task oriented. The members of the group should be individuals who have a range of experiences with the organization and who understand the general nature of the issue being discussed.

The time required for a force field analysis varies greatly, depending upon the complexity of the issues involved. If the group is dealing with a simple decision, such as which of three models of a drill press to purchase, the analysis can probably be conducted in an hour or less if all the necessary information is available. If the group is working with an issue that may require a major structural change in the organization of the institution, the group leader may want to schedule several work sessions over a period of days or weeks to deal with the analysis.

The following process steps should be carried out in completing the analysis.

Step 1: Set Up the Working Space

Flip charts or several sheets of paper taped to the wall are needed, along with several markers for writing. Each of the sheets of paper should have one of the following headings marked on it: driving forces, restraining forces, influentials, innovators, opinion leaders, and resisters.

Step 2: Orient Participants to the Purpose of the Work Session

The issues to be examined should be explicitly stated, preferably in written form. If any clarification of issues is needed, this is the best time to do so. Make sure participants know why they are involved in the force field analysis procedure and what the expected products are.

Step 3: Generate Items for the Lists

This can be accomplished by using the techniques described in the brainstorming discussion in this section (or "brainstorming" by yourself if you are working individually).

The group leader will be asked to clarify what each of the list headings represents. One of the best ways to clarify this is to explain to the participants that any social system may be considered to be a constantly changing set of forces working in opposite directions. One set of forces *(driving forces)* moves the system in the desired direction--such as that in an educational program improvement effort. Another set *(restraining forces)* prevents the system from moving in that direction. It may help to use a force field analysis chart similar to the one in figure 5.

Movement toward a desired state of affairs may be aided by (1) increasing the number and strength of the driving forces and (2) decreasing the number and strength of the restraining forces. Identification of these forces is important for the development of an effective plan. Forces for change include such things as legislation, state or federal funds, and pressure from community groups. Forces that may restrain projects might be lack of funds or resistance from community groups.

In addition to identifying driving and restraining forces, it may be helpful to

Goal:

Forces For ----------→	←---------- Forces Against
1.	1.
2.	2.
3.	3.
4.	4.
5.	5.

Figure 5. Force field analysis chart

identify three groups of individuals--influentials, innovators, and opinion leaders--who may act as driving forces if their support is secured. A fourth group, the resisters, usually acts as a restraining force that the administrator must attempt to neutralize.

Identification of *influentials* is important to force field analysis. Community influentials are persons who tend to control the wealth and power in the community and, therefore, to influence community decisions. Two means are useful for identifying these individuals: (1) the decision analysis technique and (2) the reputational technique.

In the decision analysis process, persons active in community affairs are asked to identify important recent community decisions. As much information as possible about how these decisions were made is then collected from newspaper articles, public records, observation of public meetings, and interviews. The identity of influentials may then be determined.

The reputational technique involves asking a group of persons who are active in the community to name persons whom they think have influence in community affairs and those who are wealthy and socially prominent. A second panel of knowledgeable persons then refines and limits this list to include the persons whom they view as the most influential in the community.

Identification of *innovators* is also useful in educational program improvement efforts. These individuals can be identified by certain characteristics. They usually are intelligent, read widely, and travel a lot. They tend to be risk takers who are on the fringes of the system, and they may be viewed as mavericks. They do not usually have much influence or power. They can, however, assist in program improvement by experimenting with new ideas that may then be accepted and promoted by opinion leaders.

Identification of *opinion leaders* is important because opinion leaders are much like influentials in that they have an impact on decisions. They exist in all groups and organizations. They tend to be outgoing, to know many people, and to talk a lot in groups. They are not usually innovators. Instead, they watch those who experiment with new ideas to see how the ideas work. They watch the reactions of the resisters as a way of obtaining a measure of acceptance for new ideas. They pass judgment on new ideas and promote those that work. They also act as "gatekeepers"--regulating a flow of information and resources to system members. They can play a useful part as referees or moderators in program improvement efforts.

Identification of *resisters* is critical because resisters can be a significant restraining force in a program improvement effort. These individuals are the defenders of the system as it is--the self-appointed guardians of existing standards. They play a useful part in the system because they provide stability. They tend to speak out in response to the activities of the innovators and to become disturbed when any systematic attempt to improve programs gets underway.

Summary

Each of these small-group techniques can improve the institution's ability to generate ideas and improve group-decision-making skills. Each technique may be used with different groups for different purposes. Some of the steps may be modified to fit various situations.

Chapter 6
Developing Curricular Content

A Curriculum Development Model*

There are many curriculum development models that provide structure for the development of a curriculum outline: a listing or profile of the skills, attitudes, and knowledge to be covered within a particular program, from which supplies, equipment, and instructional materials and techniques can be derived. In general, however, these models describe a simple, logical process involving five basic steps:

1. Providing an occupational analysis
2. Verifying the analysis
3. Analyzing the verified competencies (skills, tasks)
4. Translating the competencies into terminal performance objectives
5. Sequencing the terminal performance objectives

The following discussion addresses each of these steps in detail.

Providing Occupational (Task) Analyses

Once the development team is organized, the team will need to obtain the development tools that will structure their efforts. These tools are the *occupational analyses*. Basically, an occupational analysis is a listing of all the tasks (skill statements or competencies) that make up a particular job, and that are necessary for proficiency in a given occupation. Logically, if students are to be taught to be employable robotics technicians, the development team for example first must identify what being a successful robotics technician involves in terms of the competencies required.

If, after identifying and tapping all existing sources, an occupational analysis does not exist for the area in question, then an occupational analysis must be completed. An institution may be able to arrange to have this done by the state department of education staff, the vocational education staff at a local university, or an institution may arrange to

*Excerpted and adapted from *Direct Curriculum Development* (Norton et al. 1983, pp. 16-36).

share the development costs and responsibilities with other local educational agencies, or the burden may fall on the institution. If the latter is true, the institution will need to set aside needed funds for, and provide leadership to, the completion of the following first steps in an occupational analysis:

- Define the scope of the analysis.
- Prepare an initial task listing.

The occupational analysis starts with a general description of the occupation to be analyzed--drawn perhaps from the *Dictionary of Occupational Titles* (DOT)--and ends with a list of the general areas of responsibility (duties or functions), each further broken down into the specific skills *(tasks)* required.

Another occupational analysis procedure is DACUM (Developing A CurriculUM). Developed by the Experimental Projects Branch, Canada Department of Regional Economic Expansion, and the General Learning Corporation of New York, DACUM uses small-group brainstorming techniques during a 3-day meeting of 8-12 occupational area experts to generate a skill profile for a particular job or occupation area. Compared to the usual occupational analysis process, DACUM has proven to be a far more cost-effective and expeditious method for developing an occupational analysis. (A more detailed explanation of the DACUM process is in the next section.)

An organization called the DACUM Chart Exchange (DEX) is a clearinghouse for both information on DACUM and available DACUM charts for given occupations. By contacting DEX, an institution can get a listing of all available charts at no charge. Each chart costs a nominal fee (approximately $2.50). The address for DEX is DACUM Exchange; Humber College of Applied Arts and Technology; 205 Humber College Boulevard; Rexdale, Ontario; Canada M9W-5L7. Note that while DACUM charts done at other institutions may be quite helpful, it is highly desirable that each institution go through the process of verifying these charts locally or developing its own charts. This will ensure that local conditions and needs are met, and that the institution's instructional personnel will feel "ownership" of its own program.

Some programs, in the name of saving time and money, have used individual instructors (or a small group of instructors) to identify the tasks to be taught in the program. Typically, this involves simply going through a collection of texts and course outlines and selecting competencies on the basis of personal experience and preference. This approach, though widely practiced, has serious deficiencies that may significantly weaken the curriculum. The task list so identified may be incomplete, out of date, and reflect only the current interests and abilities of the instructor rather than the requirements of the occupation. This approach is hard to justify to either students, the profession, or prospective employers.

It is of critical importance in competency-based vocational training programs that an institution start with an accurate, complete, and verified competency listing or chart. Without this, no matter how well the rest of the curriculum is developed, or no matter how well the delivery of instruction is organized, the competency-based education (CBE) program is an exercise in futility. Students may be industriously achieving each specified competency in the program, but, if they are the wrong competencies, students will not be properly prepared to enter the occupation.

It needs to be pointed out that some institutions that produce their own DACUM analyses consider the charts to be final, not tentative. The charts are used exactly as produced by the DACUM Committee and are not revised in any way, nor are the identified competencies subject to further verification. There are obvious risks inherent in using the DACUM results without any further review or input: the number of DACUM Committee experts is usually limited to not more than 12 persons and the public relations value of having other qualified

workers and supervisors review the analyses is lost. Thus, some additional steps are recommended.

Verifying Occupational Analyses

Verifying the occupational analysis confirms that the items listed in fact describe the occupation and, specifically, the local occupational situation into which students will be placed. To structure the verification process, certain decisions must be made:

- Who will conduct the verification?
- Who will participate in the actual verification?
- What questions will be asked?

In all likelihood, during the decision-making stages, there would be major involvement of three parties:

- A member of the institution's administrative staff
- Staff responsible for the verification (e.g., those designated as curriculum developers)
- Advisory committee members

A member of the administrative staff must be involved. The administrator should set up initial meetings with verification staff and advisory committee members. The administrator also may prepare the agenda and record the minutes. It is the administrator who must explain to the group what decisions must be made and what and how they can contribute.

Usually, the staff involved do not have the authority to make the necessary decisions, open the right doors, or secure the needed involvement and cooperation. An administrative presence, even at a distance, is required throughout the development process. During the initial meetings, the administrator should help those involved plan the verification within the constraints of budget and staff at the institution. A "good" idea for which there are not adequate funds needs to be rethought, not squelched. Unless an administrator is present, good ideas might be lost. The administrator is the one who knows the total picture and has the authority to make any necessary adjustments.

Staff who will conduct the verification should be involved. Again, if staff is to believe in and use the results of curriculum development, an administrator must help them understand its importance. Being involved throughout the development process will help staff feel a part of this important procedure and greatly enhance articulation between academic and vocational program areas. Since they have been workers in their field, staff inputs are critical.

Advisory committees must be involved. Through common sense and legislative requirement, advisory committees have become a part of vocational education at both secondary and postsecondary levels. The advisory committee for a particular service area and the program advisory committee or craft committee are groups of citizens with expertise in the world of work who are appointed in order to provide vocational instructors with advice concerning preparation of students for employment. As such, they have a key contribution to make to curriculum development, especially to its articulation with other programs and activities. They can provide suggestions concerning what verification questions should be asked, what techniques would secure the most cooperation from employers asked to participate in verifying the analysis, and what employers should be involved. They can also participate in the verification of the list. Clearly, if the institution's occupational program has no advisory group, the institution's first step should be to appoint such a body.

At the planning meetings involving these persons, the following decisions will need to be made, with input from all members of the group:

Who Will Conduct the Verification Process?

- A member of the administrative staff, such as an evaluation specialist
- A specially appointed and trained group of faculty
- A previously appointed staff, such as a team of curriculum developers
- Other personnel

What Questions Will be Asked?

- If the institution wants only to verify the skills as real and relevant, the institution can ask incumbents simply to review each item on the analysis and check to see if it is actually performed as part of the job.
- If the institution wishes to gather other information relevant to sequencing and curriculum development, the verification instrument or interview could include other questions such as these: Is the task performed by beginning workers? How often is the task performed? How important is the task? How difficult is it to learn to perform the task?

Who Will be Asked to Verify the Tasks?

- Employees (incumbent workers in an occupation)
- Employers locally who hire workers in this area
- Employers statewide
- Advisory committee members
- With an emerging occupation, a more diverse respondent group may be required

What Key Activities Need to Occur and What Will be the Schedule For Their Completion?

- Design of instrument or questionnaire, or to interview questions
- Pilot test of instrument with limited respondent group
- Contacting of respondents
- Deadlines for completion

Analyzing Verified Competencies

Each competency (skill, task) statement needs to be analyzed--to be broken down into the knowledge, skills, and attitudes required to perform that competency. This step serves several important purposes, one of which is to provide teachers with a more detailed basis for developing instructional plans. More importantly, however, it helps the curriculum developer(s) to identify the relative "size" of the competencies listed. No matter how carefully defined and structured the analysis process has been, competencies inevitably vary in size (i.e., in the amount of time and effort required to teach or to learn that skill). By analyzing each competency, one can identify and remedy these inconsistencies.

It is difficult to describe exactly how large a competency statement should be. It can be said that a competency should not be so small and trivial as to require little or no training ("count nuts and bolts for inventory"), or so large and global as to provide little guidance for instruction ("deal with the public"). In general, a competency statement should

describe tasks that require specific instruction, and the instruction should be possible to complete within a reasonable period of time.

It is helpful to provide curriculum developers with a simple chart to use to structure the completion of this step (see table 4). Using this information, one can analyze each competency to determine (1) the subtasks, steps, or activities involved, (2) the cognitive (knowledge) elements involved, and (3) affective (attitude) elements involved. Consideration of safety relative to all three areas is of key importance. Advisory committee members can be involved in this step, also.

Translating Competencies into Terminal Performance Objectives

On the basis of the competency analysis, curriculum developers next need to translate each competency statement into a complete terminal performance objective. The competency statement describes only the performance required, e.g., "Type reports and manuscripts." The terminal performance objective adds to this statement of performance (1) a statement of the general conditions under which the performance will be done, and (2) a statement of the general criteria against which the performance will be measured. For example, a previous competency statement becomes the terminal performance objective: In office settings, given drafts of reports and manuscripts to be typed, the learner will type reports and manuscripts in correct forms to produce mailable copies according to established office procedures.

Performance:	The learner will type reports and manuscripts.
Condition:	In office settings, given drafts of reports and manuscripts to be typed.
Criteria:	In correct forms to produce mailable copies according to established office procedures.
Criteria: (continued)	

Sequencing the Terminal Performance Objectives

At this point, the curriculum developer(s) should have a list of task (skill or competency) statements for a given occupation. The curriculum developer(s) also might have a terminal performance objective for each of the competencies that were verified. The curriculum developer(s) do not necessarily, however, have a list of the occupational skills that will make up the new curriculum. At the end of this step--the sequencing of terminal performance objectives--the curriculum developer(s) will have a list of the competencies and objectives to be taught in the program, arranged in a sequence supported by instructional logic (i.e., sequenced to promote effective student learning). This is called a curriculum plan or course outline and, from this, staff can determine appropriate instructional techniques to be used and the instructional materials needed.

The larger view is needed here. The question is not "In what order should *all* of these be clustered and taught in our institution?" Instead, the question involves *which* of those skills will comprise the new curriculum. *Articulation* is a key concern here, and involvement of appropriate others is critical. The sequencing process is not difficult, but it is complex. The decision made at this point will directly affect major instructional decisions made later.

If it is determined that a program area needs to be added or an existing one revised to meet employment needs, the skills (competencies) to be covered need to be selected and sequenced according to three areas: articulation, time, and learning theory.

TABLE 4

TASK ANALYSIS FORM

SECRETARY

Duty: Prepare Written Documents

Task: Prepare a Business Letter

STEPS	STANDARDS (HOW WELL)	TOOLS AND MATERIALS	SAFETY	RELATED KNOWLEDGE			ATTITUDES
				SCIENCE	MATH	LANGUAGE	
1. Decide on letter format	business letter format used					understand business letter format	
2. Select materials	appropriate letterhead appropriate type style	stationery typeheads	avoid paper cuts			type styles	
3. Check draft for spelling, punctuation, and editing	error free					editing skills, grammar, spelling, and punctuation	caring attitude
4. Edit letter as needed		pencil/pen					
5. Type letter	error free	typewriter or word processor		typewriter or word processor			concern for quality
6. Proofread letter							
7. Make corrections or retype		typewriter or word processor		typewriter or word processor			
8. Make final check	error free neat					proofreading skills	appreciation for accuracy and neatness
9. Submit to writer	within reasonable time						

Articulation

In terms of articulation, the curriculum plan or course outline needs to take into account available secondary preparation, available postsecondary training, available on-the-job training, and employer expectations for their employees. By working together with secondary personnel, advisory committee members, and local employers, an articulated training sequence can be planned, which utilizes the available resources of each group effectively and meets both the needs of students and of local employers.

Students graduating from the secondary program will be adequately trained for employment at a certain level or for further training at the community college. The community college program will make provision for the student lacking secondary training, but will also offer training that will follow logically from, and build upon, the secondary training offered locally. And graduates from the community college program will be adequately trained for employment at a certain level. Once on the job, the graduate of either program may require specialized on-the-job training in areas (1) in which only the employer has the required equipment, (2) in which the employer has trainers available, or (3) in which the employer's practices are unique to the organization.

To have three groups working together, each with its own self-interests, requires coordination if consensus is to be reached. If your institution initiates these meetings, an administrator should be present, at least initially, to demonstrate institutional commitment to the task, to coordinate the flow of activities, and to ensure that the atmosphere is one of cooperation toward a mutually beneficial goal.

Articulation *within* the institution is also an important factor. If the machinists course to be added involves communications skills, these may be best taught through existing English courses. If computation skills are involved, these could be handled by existing, or revised, math courses. Other related skills (e.g., personal development, human relations, safety, career information, certain technical skills) may already be taught in existing vocational courses. The new curriculum, then would include all skills to be acquired by students in preparation for that occupation but, in addition, would designate those to be covered in existing courses and those to be covered by the new curriculum.

It follows then that the outcomes of these articulation efforts will be reflected in the occupational program's entry and exit requirements. The entry criteria should correspond to the level of education or training available to and usually reached by students entering a postsecondary institution from a secondary vocational school. Likewise, program exit requirements should reflect the skill attainment that local employees expect from entry-level workers in that occupation. Similarly, this concept also applies to institutionwide admission and graduation requirements.

Time

The second area of concern is time. Ideally, time should be considered a variable, not a constant. The curriculum will, however, have to be based on the available (or allocated) time. Regardless of an employer's expectations, your institution cannot provide training beyond the designated constraints of time.

Competency-based training programs in postsecondary institutions are moving strongly toward allowing students whatever time they need in order to achieve each specified competency at the required level. This provides opportunity for success to trainees with a great range of learning styles and native abilities. To make this possible, of course, administrative and instructional procedures may need to be revised.

Although these open-entry/open-exit and competency-based programs are affecting

our views concerning the limits of time, at present most schools still have their students in a course for a predetermined amount of time (i.e., as many credit hours as required for a diploma or certificate). In such cases, what is taught cannot exceed predetermined limits. If, by affixing rough time estimates to each of the skills in terms of the time needed to acquire that skill, it is determined that the skills exceed the time available, either the curriculum or the time allocated for the program will have to be adjusted. If sufficient data were gathered during the verification process, the means are available to design the curriculum according to the following principles:

- Tasks selected should be at the entry or other appropriate level of the occupation.
- Selection should be limited to basic tasks that can be learned within a reasonable level of competency.
- Tasks should be kept within the scope of the equipment available (either in-place or obtainable through existing funds).
- Tasks should be selected on the basis of their frequency of use on the job.
- Tasks should be selected that are basic to learning more advanced tasks.

Learning Theory

The third factor that must be addressed by curriculum developers and advisory committee members as they finalize the curriculum is learning theory. At this point, they have produced a list of skills to be taught and have indicated whose responsibility it is for offering training in each skill, but the list is still not sequenced in any particular order. Final sequencing can only occur later. In conventional programs, individual instructors will select specific content and organize it in a logical sequence. In competency-based programs, students will select the order in which to pursue competencies through individual conferences with the instructor, basing selection on such factors as the trainee's previous experience and present interest, and instructional efficiency. However, a general sequencing should be determined at this point. (This general sequencing is part of the final steps of the DACUM process also.)

Generally, sequencing depends directly on the nature and structure of the selected tasks and terminal performance objectives that will comprise the units of learning. In view of some of the principles of learning, it might be advisable to orient the sequence to students' developmental level rather than to the subject matter. A few of the learning principles that are related to sequencing are as follows:

- Learning is most effective when built on something the student already knows.
- Students learn step by step, but they must see how each step fits into the total structure.

If the sequential order is student-centered rather than subject-centered, the following principles may help to determine a good learning order:

1. Sequence the tasks and content for early need.

   There are times when students need to learn basic skills and knowledge before they can carry out the steps required to perform a selected task. For example, cooking success begins with exact measuring. "How to measure," therefore, must be one of the first items to be taught. This item could be considered a prerequisite needed for most cooking skills, or it could be listed as a step in learning to bake a cake. Another example is the need to

teach safety or emergency procedures, especially for potentially hazardous situations such as flying or working with machine tools.

2. Sequence the tasks based on the normal job sequence.

   For instruction that has to do with overhaul of equipment, it is necessary that certain tasks be performed in a definite order, such as disassembly, cleaning, inspecting, repair or replacement, assembly, and testing. The student must learn this order. Sometimes the most difficult task may be the very first one. In some jobs, the various tasks do not follow a regular order from simple ones to complex ones.

3. Sequence the tasks for frequency of use.

   Tasks that students perform frequently must be learned early in the training program. In a horticultural program, sterilizing the soil is a task that students must do repeatedly on their first and every successive job. This task should be learned early.

4. Sequence from simple to more complex.

   The completed curriculum should be so arranged that the more simple tasks precede the more complex ones. In an ideal situation, each task performed by the student should be a little more complex than the previous one. Usually it is not possible to get a uniform progression from simple to complex. The curriculum planner should use this progression to the extent possible, however.

5. Sequence the tasks so that each new task is built on something the student can already do.

   When new tasks are tied to tasks that the student can already do, they become more meaningful and become a springboard for further learning.

6. Sequence to provide exit points to suboccupations.

   In many vocational areas it is possible to organize the program to allow students to leave the program and get a job in the occupation without having to complete the total program. In an auto mechanics program, for example, the trainee may leave to earn a living as a brake specialist and not get training at this time in automatic transmission repair or tune-up work. Tasks in the program can be sequenced to make this feasible and efficient.

7. Sequence to initiate and maintain student interest.

   Beginning tasks can be selected on their ability to create initial interest (e.g., in a graphics program, compose and print a simple personal card). Interest can be maintained by periodically presenting a task that is known to generate fresh enthusiasm (e.g., in photography, make enlargements). By judicious selection, this can be done without doing violence to the natural sequence of events.

The process of sequencing as described here involves two aspects of learning--how much should be included in a 2-year postsecondary vocational program, and how can it best be arranged so that effective learning can take place? The advisory committee should be utilized to the fullest extent to help make these two aspects meaningful for the program.

With a thoroughly and carefully developed curriculum plan or course outline, created with the support and involvement of

appropriate staff and advisory committee members, a postsecondary institution will have a firm basis for subsequent activities involved in the supervision of instruction: assisting staff in preparing instructional objectives; selecting instructional strategies; and specifying content, time allocations, and needed tools, equipment, supplies, and facilities. In addition, a postsecondary institution will have a concrete structure upon which to base efforts to evaluate curriculum effectiveness.

Other Sources

In each state and territory, certain institutions may have completed occupational analyses. In addition, some states have developed a centralized approach to curriculum development. A standard core curriculum is often available for use by the institutions in those states. Before a curriculum development effort is undertaken, it is advisable to contact other institutions and inquire about their status in similar programming.

If a search of potential sources does not yield the occupational analysis needed, it becomes necessary to arrange for completion of that analysis. This can be done by consultants, through shared costs with a neighboring institution, or, of course, within and by an institutions staff. An especially useful means for accomplishing this is the DACUM process.

An Approach to Occupational Analysis: The DACUM Process*

DACUM (Developing A CurriculUM), is a relatively new approach to occupational analysis. DACUM has proven to be a very effective method of quickly determining, at relatively low cost, the tasks that must be performed by persons employed in a given job or occupational area.

The profile chart that results from the DACUM analysis is a detailed and graphic portrayal of the duties and tasks involved in the occupation or job being studied. An example of a DACUM chart appears in table 5. The DACUM analysis can be used as a basis for curriculum development, student counseling and recruitment, training needs assessments, worker performance evaluations, competency test development, and job descriptions.

DACUM has been successfully used to analyze occupations at the professional, technical, skilled, and semiskilled levels. DACUM operates on the following three premises:

- *Expert workers* are better able to describe or define their job than anyone else.
- Any job can be effectively and sufficiently described in terms of the *tasks* that *successful* workers in that occupation perform.
- All tasks have direct implications for the *knowledge* and *attitudes* that workers must have in order to perform the tasks correctly.

A carefully chosen group of 8-12 expert workers from the occupational area under consideration form the DACUM committee. Committee members are recruited directly from business, industry, or the professions. The committee works under the guidance of a facilitator for 2 to 3 days to develop the DACUM chart. Modified small-group brainstorming techniques are used to obtain the collective expertise and consensus of the committee.

*Excerpted and adapted from *DACUM Handbook* (Norton 1985, pp. 1-74).

TABLE 5

COMPUTER APPLICATIONS PROGRAMMER JOB ANALYSIS

DUTY		TASKS								
A	ANALYZE USER REQUESTS	Assess User Need	Assess Impact of Request on System	Consider Alternative Solutions	Estimate Time Needed	Present Proposed Solution	Prepare Written Specifications as Appropriate			
B	WRITE NEW PROGRAMS	Review Written Specifications	Develop Logic Diagram	Determine Which Language to Use	Code the Program	Compile the Program	Review the Program	Make Corrections in the Program		
C	TEST & DE-BUG PROGRAMS	Develop Test Data	Write Job Control Language (JCL)	Submit Test Run	Analyze Test Results	Correct Program Logic	Continue to De-Bug as Needed	Submit Test Results for Approval	Make Modifications as Needed	
D	DOCUMENT THE PROGRAMS	Write Operations Instructions	Write Production JCL	Write User Instructions	Update Systems Manual	Submit Docmentation for Approval	Make Corrections as Needed			
E	PROVIDE SYSTEMS SUPPORT	Respond to Call-Ins (RE: System Problems)	Respond to System Inquiries	Maintain System Documentation	Maintain Programs (Repair)	Modify Programs (Enhance)	Analyze Effects of Package Updates (Vendor Software)	Write ad hoc (one-time) Programs	Manage Multiple Work Activities to Reflect Priorities	
F	COMMUNICATE WITH OTHERS	Use Oral Questioning Techniques	Use Active Listening Skills	Prepare Periodic Status Reports	Prepare Written Summary of User Needs	Write Business Memos	Convey Technical Information	Keep User Informed of Progress	Conduct Program Walkthrough	
G	CONTINUE EDUCATION	Study User Application Area	Participate in In-House Training	Read Technical Manuals	Read Professional Publications	Participate in Seminars	Participate in Vendor Demonstrations	Participate in Vendor Classes	Participate in Professional Organizations	Complete Data Processing Courses

Because of their current occupational expertise, committee participants do not need any advance preparation. Almost without exception, participants on DACUM committees have found the activity to be a professionally stimulating and rewarding experience. The DACUM committee is carefully guided by the facilitator through each of the following steps:

1. Orient committee to DACUM.
2. Review job or occupational area of concern.
3. Identify the general areas of responsibility (duties).
4. Identify the specific tasks performed in each duty area.
5. Review and refine task and duty statements.
6. Sequence task and duty statements.
7. Identify entry-level tasks.
8. Other options, as desired.

The DACUM process usually results in the identification of 8-12 duties and 50-200 task statements that outline *what* a successful worker in a particular job or cluster of related jobs must be able to do. These tasks are then commonly submitted to a larger but still select group of workers and/or the immediate supervisors of such workers for verification purposes.

The tasks that are verified as important become the research base for developing modules or other units of instruction for the educational program. During the instructional development phase that follows the DACUM process, the verified tasks undergo a *task analysis* to determine the specific skills, knowledge, and attitudes the worker needs to perform each task. The information resulting from the task analysis is then incorporated into modules, learning guides, or other types of instructional materials for student and teacher use.

Why DACUM?

The main reason for using DACUM has been the desire of many postsecondary educators to establish a relevant, up-to-date, and localized curriculum base for instructional programs. Clearly, a curriculum base that is soundly determined with maximum input from the businesses and industries that are going to employ the students prepared by postsecondary institutions is needed. To permit any postsecondary college or other educational agency to identify a localized research base for curriculum development, an alternative to the traditional, time-consuming, and often costly approach of occupational (job) analysis is needed. DACUM is such an alternative.

DACUM is an occupational analysis procedure that has experienced remarkable success in a relatively short period of time in both Canada and the United States. Because its structure and procedures allow occupational duty and task statements to be identified effectively, quickly, and at a very low cost, DACUM has become closely associated with the movement toward competency-based education (CBE). In addition, the DACUM process has a number of characteristics and qualities that are greatly needed in CBE if it is to become a practical alternative to traditional vocational education.

First, it is a quick process; one that can be completed in only 2-3 days once committee members have been identified. Second, DACUM is certainly inexpensive when compared to the cost of traditional occupational analyses ($1,000-$2,000 will cover the cost of most DACUM workshops). Finally, the end product of a DACUM analysis, a complete competency profile of an occupation, can be favorably compared in validity with any other method. Given its present popularity and effectiveness, DACUM may soon become the dominant

approach to occupational analysis for vocational and technical education.

One additional benefit of DACUM is its public relations value to the educational institution or other agency doing the DACUM. Once employers understand the purpose and the process of DACUM, they are generally shocked to realize that a postsecondary institution really wants industry to help them identify the competencies needed by workers in their field. So many employers are familiar with the "rubber stamp" role that they are so often asked to perform on ad hoc committees (and sometimes even on occupational advisory committees) that it often takes them a while to understand that a postsecondary institution is really serious about wanting industry to help determine *what* tasks students must be able to perform in order to make program completers valuable future employees.

Once employers understand what is to be done via DACUM and how the results will be used, it is a rare employer who will refuse to cooperate. Instead, many colleges who have used DACUM report such reactions as the following:

- Offers of equipment and supplies
- Offers of resource persons to help teach in emerging technology areas
- Requests for inservice training programs to meet local industry needs
- Increased enrollments in adult upgrading programs
- Increased support of the educational institution in a variety of ways by local business, industry, labor, and management

Although the public relations value of DACUM is secondary to its main purpose, its significant, long-term impact is too important to overlook or lightly dismiss.

When Should DACUM Be Used?

Although the DACUM process has been used for several purposes, it is ideally suited for researching (1) the competencies that should be addressed in the development of new educational programs, (2) the competencies that should be delivered by existing educational programs, and (3) the relevance of existing DACUM charts.

The Development of New Educational Programs

Once the need for a *new* instructional program has been established, DACUM can be used to quickly identify the tasks that a successful worker must be able to perform on the job. Such use of the DACUM process will ensure that the new program will be relevant if the tasks (competencies) identified in the process are used as the basis for subsequent program planning and instructional development.

Review of Existing Educational Programs

A DACUM committee can be convened to identify the competencies that should be delivered in an *existing* instructional program, just as it can be convened to identify the competencies for a new program. In this case, once the competencies have been carefully identified by industry experts, the existing educational program and instructional materials are examined to see if they address all the required tasks. Modifications of the educational program are then made, where necessary, to ensure current relevance of the program.

Update of Existing DACUM Charts

The third major use of the DACUM process is to review an existing occupational profile to determine if it still

presents an accurate picture of the tasks performed by workers in that occupation. This type of updating may be conducted when the occupational profile is to be used for preparing job descriptions, conducting worker performance evaluations, making training needs assessments, or other non-curricular purposes. Depending on the occupational area and the amount of technological change occurring within it, it is usually necessary to conduct a DACUM-update workshop session on the average of *once every 3 years*. Even then, an active advisory committee will probably need to make additional changes in between the workshops in order to maintain a curriculum that is responsive to today's business, industry, and public service needs.

Special Applications

DACUM has also been successfully used in what could be called "special applications" of the basic process. For example, in cases where qualified workers could not be released for a 2-day workshop, modified DACUMs in which literature reviews were used to identify all relevant duties and tasks have been conducted with reasonable success. In these cases, 1 day has generally been adequate for the committee to review and accept, modify, or reject each duty and task statement derived from the literature.

DACUM has also been used successfully by the National Center for Research in Vocational Education to identify the competencies required of workers when they are engaged in a specific portion of their total job. For example, vocational teachers who have been successful in implementing competency-based education have been able to identify the additional competencies needed by traditional teachers who want to convert to the CBE approach.

A similar approach has also been used to identify the additional competencies needed by vocational teachers who need to assist students in improving their basic skills and who are responsible for serving students having special or exceptional needs.

Another successful adaptation of DACUM has been its use in identifying the tasks that vocational educators (specifically, teachers and administrators) should perform in order to implement sex-fair vocational education programs.

DACUM Quality

Although the DACUM process lends itself to a number of regular and special adaptations, two critical factors are always necessary to obtain a valid DACUM chart. The *first* is to assemble a committee of 8-12 experts in the area under study, and the *second* is to use a *trained DACUM facilitator*. Without both of these, the resulting analysis is questionable, at best.

Because of the widespread concern about DACUM being conducted in a high-quality manner that ensures valid results, a "DACUM on DACUM" was conducted at the National Center for Research in Vocational Education in October, 1982 to identify the tasks required of the DACUM coordinator and facilitator. The resulting DACUM coordinator's and facilitator's profile was the research base for developing the *DACUM Handbook*. The handbook and the DACUM coordinator's and facilitator's profile are available from the Publications Unit of the National Center for Research in Vocational Education.

A number of DACUM conventions or standards have also been established by experienced facilitators as "rules of thumb" that should always be adhered to if the process used is to be labelled a DACUM occupational analysis. The conventions are as follows:

- The coordinator/facilitator is qualified through training and practical experience.

- Committee members are expert workers and immediate supervisors of such workers in about a 5:1 ratio.
- Committee members participate during the entire workshop.
- Task statements abide by all of the criteria for acceptable task statements.
- The same task statement appears only once.
- There are 8-12 duty areas for most occupations.
- There are six or more task statements in each duty area.

What Are the DACUM Procedural Steps?

The DACUM committee is carefully guided through each of seven procedural steps. These steps are described in the following paragraphs.

Step 1: Orientation of Committee

The goal of this step is to provide an introduction to the DACUM process and to explain to the participants the importance of their role in it. During this introduction, emphasis is placed on the rationale for employing this technique, which includes the fact that, in a very short period of time and with low cost, DACUM can be used to identify the tasks (competencies) important to an occupation.

Step 2: Review of Occupation

The purpose of this step is to arrive at a mutually acceptable working definition of the occupation to be analyzed. During this step, the related job titles and specializations to be included in the analysis are clarified.

Step 3: Identify General Areas of Responsibility

Using a working definition of the occupation as a springboard, the third step in the process involves determining the general areas of responsibility or duties of the occupation. The resulting statements reflect functional areas of responsibility under which all the specific tasks will fit. Most occupations are subdivided into from 8-12 duty areas.

Step 4: Identify Specific Tasks Performed

The fourth step involves taking each duty area and specifying the six or more tasks that are performed by workers fulfilling duties in that area. This step takes the most time, as commonly 50-200 tasks may be involved, depending on the complexity of the occupation. Each task statement begins with an action verb and describe an observable behavior.

Step 5: Review and Refine Task and Duty Statements

After specific tasks have been identified for all areas of competence, each task and duty statement is individually reviewed. This process usually results in a considerable number of changes that improves the clarity and precision of the statements.

Step 6: Sequence Task and Duty Statements

After the refinement of task statements from each area of competence, the committee organizes the tasks into some logical sequence.

Step 7: Identify Entry-Level Tasks

Once the analysis of the occupation is completed and if time permits, the

committee is asked to specify which tasks on the chart are considered entry-level skills versus those which are considered advanced skills and are not expected of a beginning worker.

Why Verify the Occupational Analysis?

After DACUM workshops, the institution has an occupational analysis listing all of the tasks workers perform in that occupation. It was obtained from expert workers and supervisors. However, the tentative task list most likely should be subjected to further verification by other experts.

"Verifying" the tasks is a process that confirms that the tasks listed are, in fact, the tasks that students will need to be able to do when they enter the occupation locally. The tasks should be submitted to people currently active in the occupation for their critical examination, and they should be asked to consider each item and determine whether that item is, or is not, actually a part of the occupation. They may also suggest additional tasks that appear to have been omitted.

In addition, other types of data, such as frequency of performance, importance of the task, and the difficulty of learning, may be obtained readily through the verification, process. Each institution has to consider the costs and benefits of verification and decide which approach will better serve its needs and desires.

The degree of sophistication and type of verification process used can vary widely. A fairly comprehensive verification study may be needed for new curricula for which little information is available.

The DACUM coordinator is usually the person who conducts the verification survey. Other persons, however, who possess the necessary data collection and analysis skills also may conduct the verification. In all likelihood, three other parties will need to be involved: (1) an administrator who can give the necessary approvals, (2) the curriculum specialists and instructors, and (3) advisory committee members. As with the identification of DACUM committee members, the latter two groups often are able to assist with the identification and selection of verifiers.

When preparing a survey or task inventory instrument, the number of questions asked must be kept to a minimum in order to ensure a better rate of response. Only that information that is relevant to the institution as it proceeds to organize and develop a responsive curriculum based on the DACUM analysis should be gathered.

Verifiers should consist of a group of expert workers in the occupation and/or the immediate supervisors of workers who have direct responsibility for getting work done. A program's occupational advisory committee may be satisfactory. An approach sometimes used to collect the data needed is to convene a special verification committee, solely for the purpose of reviewing the task statements. Probably the most efficient and most frequently used data collection procedure is the mailed questionnaire.

When the data have been collected and summarized, they are interpreted to determine changes needed in the tentative task listing. These judgments must be made, probably with the help of the advisory committee.

Once the tasks for an occupational program are verified, an institution has a solid research base on which to build an effective vocational training program.

There is no single best way to institutionalize the use of DACUM charts. Most institutions use teams to revise their existing curricula or to develop new curricula based on the DACUM findings.

One of the major tasks undertaken by most institutions is to conduct a *task analysis;* that is, to analyze each verified task in order to identify (1) the steps/activities involved, (2) the related

knowledge required, (3) the attitudes involved, (4) the performance standards expected, (5) the tools and materials needed, and (6) any safety concerns. This step serves several very important purposes, one of which is to provide teachers and others with a more detailed basis for developing curriculum. More importantly, however, it helps the curriculum developer(s) determine the instructional time required for each task (competency).

In addition to a thoroughly and carefully prepared occuaptional analysis, educators of adults must select appropriate instructional strategies. The following sections that disucss adult development information and adult retention strategies provide some practical guidelines for the curriculum developer.

Using Adult Development Information in Adult Education*

Adult development theory is a relatively new area of investigation and, as such, there are still many unresolved issues, contradictory findings, and perplexing questions. Furthermore, there are limitations in translating theories of adult development into practice. What does a practitioner do with the "deadline decade," "generativity versus stagnation," or "childhood demons," for example? That is not to say, however, that there is no knowledge from adult development theory that can be applied to practice. There is, and after having explored the interrelatedness of the two areas, it is clear that one affects the other whether the interaction is planned or not planned.

Rather than being a deterrent, the newness of adult development information offers a challenge to adult educators to apply this knowledge cautiously and creatively to practice. It is interesting to note that childhood education has always been linked to child development. What person preparing to teach children has not had a course in child development or adolescent psychology? Systematically examining the same connection for the adulthood phase of the life span not only seems appropriate but necessary if adult educators are to serve their clients effectively. The implications of adult development for practice will be discussed here in relation to the two broad areas of program development and instruction.

Program Development and Administration

Program development is broadly conceived here to include the institutions, agencies, and individuals who plan and administer programs for adults. Adult development can form a basis for the overall structure of a program, it can provide the content of the program, and it can guide planners in attending to the barriers to participation encountered by potential learners.

In planning and administering programs for adults, a knowledge of adult development can help planners understand the need for and type of support services necessary to the program's success. Such knowledge also sheds light on the barriers adults face when considering engaging in adult learning activities. For example, child care provisions should be made for programs designed to attract young adults. Transportation and scheduling are crucial factors in offering programs for older adults. These are listed by Cross (1981) as situational barriers--"those arising from one's situation in life at a given time" (p. 98). Cross gives examples of lack of time for 25- to 45-year olds due to

*Excerpted and adapted from *Adult Development: Implications for Adult Education* (Merriam 1984, pp. 24-29).

demanding work and family responsibilities, lack of money for young people and other low-income groups, lack of child care for young parents, and lack of mobility for the aged and handicapped.

Another type of barrier, institutional, is defined as "those practices and procedures that exclude or discourage working adults from participation in education activities--inconvenient schedules or locations, full-time fees for part-time study, inappropriate courses of study, and so forth" (p. 98). Cross's third category, dispositional barriers, has to do with the attitudes and perceptions of oneself as a learner. Darkenwald and Merriam (1982) call this category psychosocial and note that it actually has two dimensions:

> Psychosocial obstacles tend to be related either to education or learning as entities or activities, or to the self as a learner or potential learner. The first category encompasses negative evaluations of the usefulness, appropriateness, and pleasurability of engaging in adult education. (p. 139)

With regard to the self as learner, barriers have to do with negative perceptions of ability (especially if returning to education after a long hiatus), fear of not being self-disciplined enough, and fear of not being able to compete with younger learners. Probably more powerful deterrents than situational or institutional barriers, the psychosocial concerns of potential participants reflect past negative experiences with education and an acceptance of some of the myths about aging, learning, and intelligence.

Program planners and administrators can use the knowledge base of adult development to provide an overall structure or program perspective, to develop specific content, and to understand and alleviate the barriers to participation encountered by potential learners. Knowledge of adult development can also be used to revitalize existing programs. This is probably a more realistic option for most institutions that are locked into funding patterns and prescribed policies and procedures.

Chickering (1981) presents a thoughtful and practical set of guidelines for ensuring the development of learners in higher education. Institutions have a range of options for doing this through teaching practices, student-faculty relationships, sources of evaluation, and institutional functions. Instructional techniques can match and stimulate a student's level of development. The student-teacher relationship can vary from the teacher being an authority to being a colleague, just as evaluation can be conducted by a teacher, peers, or self. The "hidden curriculum" of any institution has an impact upon the people it serves. Chickering suggests that the institution itself can offer opportunities and challenges for continued development. Of these possibilities for linking adult development and institutional functions, Chickering (1981) writes:

> We can modify our typical institutional practices in directions that recognize developmental diversity and help students at each stage move toward higher levels. Every institution will enroll students at all of these developmental levels. Because of this diversity, it cannot simply pitch its educational program at any one particular stage. . . . Alternatives need to be created that serve students at all levels. Institutions must be responsive to the full range of developmental stages and learning styles brought to them by the students they aim to serve. (p. 782)

Instruction

As Chickering suggests, instruction is one area in which educators can apply knowledge of adult development both to match and challenge the developmental stages of learners. An instructor who has an understanding of adulthood and appreciates the differences between children and adults as learners can maximize learning

through the use of appropriate instructional strategies.

Two of the assumptions underlying andragogy proposed by Knowles (1980), one dealing with self-concept and the other with experience, are particularly relevant to understanding the link between development and instruction. Knowles (1980) observes that as a person matures, his or her self-concept moves from one of a dependent personality toward one of a self-directing human being. This factor has both philosophical and practical implications. It offers the adult educator a developmentally based goal--"enhancing the learner's ability for self direction in learning as a foundation for a distinctive philosophy of adult education has breadth and power. It represents the mode of learning characteristic of adulthood" (Mezirow 1981, p. 21).

From an institutional standpoint there are several techniques available to enhance an adult's movement toward self-direction. Overall, adults who daily make decisions affecting their lives and the lives of dependents are capable as well of participating in the planning and implementation of their own learning. They are also able to judge the value of a learning experience. Thus adults, since they are more or less autonomous and self-directed, should be allowed to contribute to the planning, implementation, and evaluation of their own learning. This requires the teacher to assume a stance other than the school-based stereotype of authority figure, transmitter of knowledge, and judge. Chickering (1981, p. 779) suggests a sequence of teacher roles, each allowing for more independence on the part of the learner. A teacher can be a "model" with whom students can identify, or, in situations where programmed materials or mediated instruction are used, an "abstraction" behind the system. Teacher as "resource" and finally "colleague" are the two roles that offer the student respect as an independent person and that foster self-direction.

Contract learning is one specific technique that can be used within even highly structured institutional settings to enhance self-directedness. Contract learning can also accommodate the range of development to be found in a group of adults. All the ingredients of a learning activity can be individualized through a learning contract: objectives, place and time of learning, content, actual activities and resources, and evaluation (Clark 1981). A learning contract addresses each of these components and the extent to which the components are negotiated between student and teacher reflects both the role of the teacher and the autonomy of the student. Clark observes that most faculty have to learn some new roles to be able to help implement contract learning. At one time or another, faculty functions as facilitator/counselor, broker/negotiator, instructor/tutor, evaluator, administrator, developer of learning resources, creator of instructional materials, and planner of individualized degree programs.

The second assumption of andragogy that links development and instruction is the idea that an adult "accumulates a growing reservoir of experience" that both defines that person as unique and offers a resource for learning (Knowles 1980, p. 44). Instruction can be designed to take advantage of an adult's life experiences and expertise. As a matter of routine some instructors have their adult students identify what they can offer to other learners--their special talents, skills, experiences, or knowledges that could be shared with others. Experiential techniques such as small group discussions, seminars, field trips, simulations and games, case studies, and so on actively engage learners and make use of their past experiences. Menges (1981) discusses in some detail how small groups can foster the development of psychomotor skills, emotions, memory, cognition, and "nonlinear" thinking such as the ability to formulate problems as well as solve them.

Portfolios are another technique for acknowledging an adult's experiences. While contract learning proposes the learning that will take place, portfolios document prior learning. Used in many higher

education settings as a basis for awarding credit for prior learning, the experience of assembling one can be in itself growth producing. In reporting on the use of portfolios at Sinclair Community College in Dayton, Ohio, Krueger (1982) notes that portfolios helped students get jobs, resulted in increased self-esteem, and provided an opportunity for reflecting upon "phases, careers, and relationships" in their lives (p. 89).

The teacher-learner interaction and instructional techniques also are affected by what is known about learning ability as adults age. Although inherent learning ability appears to remain stable during most of adulthood, noncognitive factors have been found to affect a person's performance on particular learning tasks. Three factors in particular are age linked in their impact on learning:

- Pacing or speed refers to the time a person needs to examine a problem, respond to a task, or recall information. This ability decreases with age. Learning activities should have few, if any, time constraints. Optimum performance results when adults are allowed to pace their own learning.

- Meaningfulness, or how personally relevant or familiar material is, makes a difference in learning especially for older adults. Drawing upon an adult's experiences is one way to ensure that the activity will be meaningful.

- Motivation, or the extent to which an adult is interested in learning a particular skill or information, affects both participation and learning ability. Other noncognitive factors that affect learning and that are age or cohort related are level of formal education, social class, and physical health.

Development thus affects instruction from the perspective of what is known about changes in learning ability, an adult's life-experiential base, and the movement toward an independent self-concept and self-directedness in adulthood. Weathersby and Tarule (1980) delineate the basic variables in a teacher-student interaction that can be adjusted according to the developmental stage of the learner and the stage one might be trying to effect:

> Crucial aspects of a situation appear to include the amount of structure provided by the instructor for the intellectual tasks given to students; the degree of diversity in the situation; the amount of direct experience provided in relation to more cognitive content; and the degree of 'personalism' or personal acknowledgement and relationship incorporated in the learning situations. Students at the lower stages need more structure, less diversity, more direct experience, and a personal atmosphere in the classroom. (pp. 47-48)

Tailoring Curriculum to Adult Students*

Retaining adults in educational programs is a major challenge for adult educators. For the most part, however, the problem has been cast in limited terms. Instead of asking what can be done to prevent students from dropping out, almost all the research and writing on this topic has been restricted to examining who drops out and why. Although this literature offers clues to enhancing retention it is incomplete, for it fails to address how eductors can design and implement superior programs so that retention can be relegated to a minor concern.

Research Findings on Who Drops Out and Why

The following pages summarize the research findings on who drops out and why. The practical guidelines for promoting adult student retention also are discussed.

Program Context Factors

Program context factors can be controlled by adult occupational educators and thus are potentially important for enhancing retention in adult education programs. Context variables are administrative or organizational properties of educational programs, such as frequency and length of class meetings, class size, provision of support services, and the like. It seems useful to distinguish these variables from the more immediate factors that arise from or impinge upon the teaching-learning process itself.

The common-sense belief that number of course sessions is directly related to dropout rates is supported by research. Anderson and Darkenwald (1979) found a significant negative association between number of weeks scheduled and persistence. This was true even with 20 other variables statistically controlled. Similarly, a statewide study in Wisconsin found that dropout rates were lower in courses meeting for fewer than 20 sessions (Wisconsin State Board 1969). Frequency of meetings (in contrast to total number) has also been shown to affect dropout rates. Less frequent meetings (e.g., weekly or biweekly) are associated with higher persistence rates (Verner and Davis 1964). The findings for class size are mixed, although Boshier (1973, p. 266), in a study of 2,436 New Zealand participants in noncredit courses, reported lower dropout rates in classes with nine or fewer students. Other potentially important programmatic variables, such as the comfort or "adultness" of the physical environment, and availability of support services, such as counseling and child care, have been neglected by researchers.

These findings, although sketchy, have at least some practical implications for increasing retention in adult education programs. Time is a scarce and valuable resource for most adults; like fees or tuition it must be considered a cost of participation. Time per session or even total course time may be less important than how time is scheduled. Whether a class meeting is an hour or three hours is probably of less importance for most adults than the disruption of daily routine caused by frequent meetings. Thus, less frequent meetings, even if longer in duration, would probably facilitate retention in most adult education programs. Another alternative is to schedule large blocks of time--a day or two or a weekend--on the assumption that one big disruption is more manageable for many adults than a drawn-out series of little ones.

Teaching-Learning Factors

Teaching-learning factors are those variables that arise from or directly and

*Excerpted and adapted from *Retraining Adult Students* (Darkenwald 1981, pp. 6-17).

immediately influence the teaching-learning process. They include learner and teacher expectations, motivations, and overt behaviors; classroom climate and interaction patterns; and numerous other variables that characterize the teaching-learning transaction. The research suggests that these factors are far more important than others in accounting for dropout rates from adult education (Anderson and Darkenwald 1979, Boshier 1973, Irish 1978, Verner and Davis 1964). Variables connected with the teaching-learning process are of considerable practical importance because many of them are subject to control by adult educators concerned with enhancing student retention. Research related to student goals and expectations will be considered first, followed by studies that emphasize teacher behavior in relation to the dropout rate.

The extent to which a course or other organized learning activity is relevant to, or congruent with, student needs and objectives is probably the major determinant of persistence. Students are more likely to persist when they have clear or concrete goals, when their goals or expectations are capable of being satisfied by a particular educational experience, and when they perceive the learning experience to be instrumental in helping them satisfy their needs or objectives (Irish 1978). Studies of attrition from high school completion and human resource training programs illustrate these assertions. Londoner (1972, p. 185) found that persisters in a high school completion program tended to rate "obtain a high school diploma" as an important goal, while dropouts tended to assign more importance to less immediate and realistic goals, such as "increase one's earning capacity." Similarly, Lewis et al. (1971) found that participants in a human resource training program initially expected that the training would help them obtain satisfying employment. When it became clear that the training would not automatically lead to good jobs, they dropped out. The lesson seems to be that when learners expect too much or "something else," or when the educational program delivers too little or "something else," the likelihood of dissatisfaction and, therefore, the dropout rate is high.

Oddly, few studies have examined the relationship between teacher behavior in the classroom and the student dropout rate. The studies that have done so are suggestive. An investigation that correlated 10 teacher behaviors with dropout rates from civil defense education courses (Davis 1966) uncovered only one significant finding: dropouts more often than persisters reported that teachers did not talk to them as equals. Lam and Wong (1974) conducted a study of attendance rates in extension classes taught by the same instructor at the Chinese University of Hong Kong. Interestingly, student perceptions of this teachers' behavior varied markedly. Students who perceived him as "approachable" did, however, attend class more regularly, as did students who reported that the course's content met with their expectations; that they were able to understand or "follow the course," that they had opportunities to clarify their doubts or take part in discussion; and that they more often "chatted casually with the instructor" (Lam and Wong 1974, pp. 133-136).

Whether or not a teacher has professional training (Verner and Davis 1964) or employs certain teaching methods, such as lecturing (Anderson and Darkenwald 1979) seems to have little impact on dropout rates. However, the relevance or significance for the learners of what is taught seems to be closely linked to attrition. A study based on a national sample of ABE teachers in large cities (Darkenwald 1975) found that black teachers of classes composed primarily of black adults reported lower dropout rates than did white teachers of such classes. Further investigation revealed that black teachers tended to place greater emphasis than whites on the "nontraditional" subject areas of consumer and health education, racial heritage, and coping skills (e.g., applying for a job, obtaining legal assistance). When the teacher's race was controlled by amount of "nontraditional subject emphasis" it became clear that most of the variation in dropout

rates could be accounted for by subject-matter emphasis. Thus teachers, whether black or white, who were sensitive and responsive to the needs of black, inner-city adults were more likely than other teachers to retain these adults in their classes. Other studies (e.g., Adams 1974) have found large discrepancies between what adult students report as their needs or goals and what their teachers perceive as the students' needs or goals. This kind of incongruence is almost certain to result in dissatisfaction and an increase in the dropout rate.

Implications of Findings for Retaining Adult Students

Strangely, it appears that there has been no experimentation focused on *retaining* adults in educational programs. It is therefore necessary to speculate, on the basis of dropout research, what steps might be taken, or variables manipulated, to enhance retention. Since research suggests that the most important variables in accounting for dropout rates from adult education are those over which the teacher has the most control, for example, teaching-learning variables, then it follows that retention can be enhanced through careful attention to adult education principles in program planning. Some practical implications in this regard have been noted in the foregoing review of research and theory. These implications will be expanded below in general guidelines for promoting student retention. The guidelines suggest that to retain adults, learning experiences should encompass the following:

- Address real needs.
- Create a supportive learning environment.
- Minimize environmental problems and barriers.
- Communicate course content and expectations accurately.
- Follow-up potential dropouts.
- Evaluate to identify and correct potential problems contributing to dropout rates.

Addressing Real Needs

Above all else, adults expect that a course, workshop, or other educational activity will benefit them in specific ways: they expect, in short, that it will meet their needs. As Beder (1980) has pointed out, needs assessment, although often difficult, is nonetheless absolutely necessary in adult education. Programs that do not assess and address adult needs and interests almost always have high dropout rates.

There must be congruence between what the program provides and what adult students need and want. For a fuller discussion of this point and examples, see Beder's (1980) analysis of marketing principles applied to adult education program development.

Creating a Supportive Learning Environment

Most adults expect a supportive and flexible learning environment in which they are treated by the teacher as equals and social relations are comfortable rather than tense or competitive. Undereducated adults, and those who return to the classroom after a long hiatus, often lack self-confidence and may even experience considerable anxiety. Teachers should be sensitive to these fears and doubts and make every effort, particularly at the first meeting, to allay them. Rusty study skills can be a problem too. Teachers should not assume that all adults can use the library effectively or fully grasp the meaning of academic terminology such as *bibliography* or *term paper*. It is also important for teachers to be aware of the value (i.e., scarcity) of time for adults; it is a resource not to be expended unless

necessary. Finally, teachers should adapt instruction as much as possible to accommodate students' particular needs, goals, and abilities; let students know what is expected of them and what they can expect in turn; and provide frequent feedback on student performance in a sensitive, constructive manner. These observations may seem like common sense, but in practice they are widely ignored or violated. Many teachers of adults are not professional educators, and those who are seldom have training in adult education. Adult education administrators must give higher priority to staff development if they wish to improve teacher performance and thereby student retention.

Minimizing Problems and Barriers

Program developers and administrators can do a great deal to counteract negative environmental reinforcers. Accessibility, flexibility, convenience, efficiency, and sensitivity are particularly germane in this regard. The role of student is a secondary one for adults. If it interferes too much with other, primary roles and responsibilities, most adults will feel compelled to drop out. The importance of minimizing disruption of daily routine has already been noted. Accessible learning sites, convenient scheduling, and even the provision of child care or transportation services may be necessary to enhance student retention. Important support services, such as counseling, should be available on a convenient basis. Although lack of time, inconvenience, and other such frustrations are not the principal causes of students dropping out, there is no question that such negative reinforcers contribute to the problem.

Evaluating

It need hardly be said that if a class or program is experiencing higher-than-expected dropout rates, evaluation is necessary to identify and correct the problem. Often, simply observing and conferring with the teacher is sufficient to resolve the difficulty. In other cases, where the problem is widespread or chronic, a more formal and comprehensive evaluation effort may be needed. It is important to develop a system for recording and monitoring attendance and dropout data so that problems can be identified and dealt with as quickly as possible.

It is tempting to conclude with the injunction: "Assess needs accurately and deliver a good program, and retention will take care of itself." It is almost, but not quite, as simple--and as complicated--as that.

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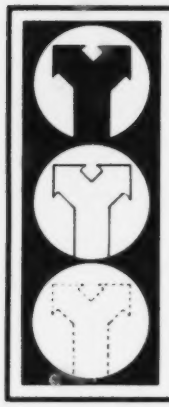

Chapter 7
Implementing a Curriculum

The Implementation Planning Process*

Implementation of a new course or curriculum is the most crucial phase of the program improvement process. Unless the implementation is conducted properly, needs assessment and successful selection are not as valuable as they should be.

The major steps in implementation are as follows: preparation and planning, installation, and evaluation of the operation and impact. (For the purposes of this handbook, evaluation is discussed independently; in "real" life, the implementation and evaluation are planned together and become an action plan for program improvement.)

Effective implementation takes time. Movement from initial installation to a fully implemented program cannot be done overnight. Impact on students cannot be expected immediately. During this period, program adaptions, both planned and unplanned must be made. Do not be disturbed, for this is a natural part of assimilating the new program into a system. However, be certain that the critical characteristics of the innovation are not lost during installation.

Preimplementation Steps

When the decision is made to install a new course or curriculum, the process of change has just begun. Careful planning is essential. Regardless of the effort to develop the best possible course or curriculum, the innovation will fail if the total institutional setting has not been prepared properly. In other words, the institution must be prepared by going through what Preston (n.d.) refers to as preimplementation steps.

According to Preston, preimplementation planning includes attempts to resolve potential problems such as personnel concerns, the fit with the current curriculum, scheduling difficulties, and the like. While these difficulties may have been considered during the selection phase, they now must be dealt with in detail. Administrators and staff should be very familiar with the innovation and, therefore, be able to approve the next steps in planning. The general impact of the innovation on the staff should be assessed at this point. Those persons who actually implement the program should be assured that potential problems can be resolved.

*Excerpted and adapted from *Problem-Solving Process: A Planner's Handbook for Program Improvement* (Kowle, Smink, and Stank 1982, pp. 52-27).

In order to prepare for implementation, it is advisable to establish an implementation task force at the institution. This task force could be the same as the team that has been involved in developing the curriculum or it could have representation from the team. The task force will be responsible for developing a detailed action plan. Measurable objectives, a time line for planning and implementing activities, and a functioning communications network all will contribute to the success of the task force. The preimplementation phase also is the appropriate time to design staff development plans for the introduction of the new course or curriculum. Budget projections should be completed as much as possible during this phase; staff assignments should be settled. Any necessary staff training or product adaptation should be completed before actual implementation. It also is important to create a positive climate before the innovation is actually introduced. If a major new program is being implemented, the entire institution--and the community--should be introduced to it.

Table 6, adapted from Schriner (1979), could be used to develop a plan for gaining support for the selected program curriculum.

The Implementation Process

In order to ensure a smooth installation of a product or practice, an action plan must be developed. The main elements of the plan are as follows:

- *Administration and management*--timing, budget, scheduling, facilities, staff assignments, and monitoring
- *Staff development*--preinstallation training and ongoing technical assistance

TABLE 6

STRATEGY OUTLINE FOR GAINING SUPPORT FOR PROGRAM OR CURRICULUM

Activities	Responsible Persons	Needed Steps	Time Line	Anticipated Outcomes
Obtain support of participating instructors	Site coordinator	Meet with instructors	June	Instructors will examine and approve program and curriculum.
Obtain support of administrators, (president, board of trustees)	Site coordinator, team members	Meet with appropriate individuals; provide documentation on the program and curriculum	June	Administrators will examine the program and curriculum and "go on record" as approving.
Obtain support of other groups (e.g., Chamber of Commerce, business and industry, labor, community groups)	Site coordinator	Conduct a series of meetings	June and August	Groups will be aware of new program and curriculum and will approve.

- *Materials and equipment*--ordering, updating, and distribution and use

It is important that roles are clearly defined and that leaders are confident about their responsibilities. Materials should be distributed and regular meetings conducted, especially during the beginning weeks.

The action plan will require continuous review during the entire phase. Actual activities should be compared with specific program objectives and the program should be monitored at the operational level. The budget also will require continuous review. The program or curriculum may require some alterations and this should be taken into account in the evaluation.

A positive environment can be maintained through participatory management, flexible attitudes on the part of staff, and a systematic communication network. Where the innovation directly involves students, consideration should be given to including their input into program assessment and modification. A continuing relationship should be maintained between new and existing programs. Preston (n.d.) also emphasizes that persons who will be involved actively in the program should feel a sense of ownership.

The Implementation Plan

The implementation plan will take into account many of the considerations of the preimplementation stage. The plan should identify the staff members to be contacted (and for what reasons) so that the implementation process can begin properly. It also should identify possible problems. The task force already will have information on past successes and existing problems. Overall agreement should have been reached on the goals. All of these factors should have been clarified by the earlier steps in the process. Information on goals, needs, and product evaluation will expedite the development and execution of the plan. The following items should be considered:

- *Program timing and budgeting*--time to prepare for proper implementation; firm dates for implementation activities; and budget or steps to seek approval of the budget, if it has not been approved

- *Staff assignment, orientation, and training*--instructional staff assignments; training programs for institution staff; and orientation for administrators, teachers, parents, employers

- *Materials, equipment, and facilities*--list of needed materials and equipment; ordering of materials and equipment; inventory of materials; arrangements for distribution of materials or installation of equipment; necessary facilities reserved and schedules prepared; and modifications in existing facilities

- *Student scheduling and instructional procedures*--scheduling students; notifying students and their parents; instructional procedures clearly defined in program descriptions or published manuals; media identified; scope of each activity clearly defined; sequence for each activity; and variations in scope and sequence for self-paced instruction

The following questions, adapted from Schriner (1979), should prove helpful to program planners:

- Whose support is needed to gain acceptance of the program or curriculum?

- Which instructors will be involved?

- When should the implementation begin?

- Why was the program or curriculum selected?

- How much time and money are invested in the program and curriculum?

- Where will the program or curriculum be used and what arrangements have to be made?

- How will we know if the program or curriculum is successful and whose responsibility is it to evaluate the outcomes?

- If the outcomes are not those intended, what kind of backup plan is needed?

Lastly, figure 6, a sample chart for implementation planning, could be used--or adapted--as needed:

Steps in the Implementation Process

Preparing an implementation plan for approval involves several steps. These steps are as follows.

Step 1: Determine the content of the plan. Include the following:

- Major activities
- Facilities
- Equipment
- Staff requirements
- Staff training
- Staff responsibilities
- Time lines
- Costs

Step 2: Complete the drafting of the plan as follows:

- Write program description.
- List major activities.
- Complete details of the plan.
- Write the actual plan.
- Select a director for implementation.
- Complete implementation chart.
- List major tasks.
- Assign person to each task.
- Establish target dates.
- Estimate cost.

Improvement to be Implemented	Major Activities Required to Implement	Person Responsible	Steps Needed to Implement	Time Line	Anticipated Outcomes

Figure 6. Sample chart for implementation planning

Step 3: Submit plan to the board of directors.

Step 4: Negotiate terms of funding.

Step 5: Secure approval.

During the implementation planning process, it is important to be aware that some resistance to the curriculum changes may become evident. The following section discusses some strategies for overcoming this resistance.

Strategies for Overcoming Resistance*

Given that change is a people process, it is important to go about implementing improvements in a way that takes interpersonal dynamics into account (Hull and McCaslin 1977). Perhaps the greatest mistake one could make as an advocate of change would be to impose it from above. Change mandated from on high in this way is most likely to be feared, resented, and even resisted by the people who are asked to change. It is better to involve those people in the implementation process and to influence their opinions and behavior in favor of the curriculum changes you propose to implement.

A number of techniques can be used to involve and influence the people who will be implementing the curriculum. The techniques might be used throughout the implementation process, for they focus not merely on the mechanics of carrying out change but also on the interpersonal dynamics of change.

The individual techniques that can be used to influence and involve other people fall into three basic categories:

- *Information.* To influence people to go along with change, provide them with information. Very often an administrator has information of which department heads and instructors are not aware. The opinion that particular curriculum changes are needed is based on knowledge of particular problems. Others, who are not aware of these needs because their own duties and perspectives are more limited, may well see no reason to make changes. If these people are provided with this information, they will be much more likely to agree that change is in order.

- *Persuasion.* Informing people of needs that exist and changes that should be made to meet those needs is not always sufficient to influence their opinion. Sometimes it is necessary to use the fine art of persuasion. Persuading people to agree with an opinion and approach usually involves making them aware of their own personal stake in the issue. Many people will see their own stake in the proposed curriculum changes if they take part in planning and executing it; they feel a sense of ownership in the change that they help design and carry out. Likewise, people often come around to a point of view if they encounter a situation in which *they* experience the need being addressed.

- *Direction.* Finally, if both information and persuasion fail to influence people in favor of a needed innovation, the use of direction is possible as a last resort. Giving orders or instructing people that they must do something is not pleasant. However, if resistance continues in spite of efforts to involve and influence, it may become a necessity. Directive techniques are usually the least productive in bringing about change, since they generally aggravate people and make

*Excerpted and adapted from *The Unfinished Agenda: An Implementation Guide* (Samuelson et al. 1985, pp. 6-14).

them less willing to accept the changes in question.

Some further discussion and examples of these three categories of techniques follow.

Information

Perhaps the first information technique to come to mind is inservice training for instructors. Inservice sessions to prepare instructors for curricular innovations can provide a wealth of information. Only time and imagination limit the information that can be conveyed in such sessions.

Print or audiovisual materials can be developed to create awareness of both needs and improvements. A flyer or small brochure could be developed and distributed to administrators and instructors to disseminate employment and unemployment statistics; such statistics could clearly point out the need to increase access to vocational-technical education programs for all students. A slide-tape presentation or film might show supervisors or instructors how modifications can be made to adapt existing equipment and facilities to new curricula.

A symposium of instructors and department heads from all areas, academic and occupational, could cover information on curriculum coordination at a staff development meeting.

Other techniques might be used to gather information necessary for implementing improvements. Brainstorming (presented in a previous section) and discussion with teachers and administrators can help identify concerns about changes proposed. The teachers and administrators also may contribute information about specific effects of changes in their immediate environment, or they may make suggestions that will help implement innovations. Information also might be gathered from people by using survey techniques.

Case in Point: Mass Media

One informative technique that is frequently overlooked is mass media. This term brings to mind public service announcements on television or radio at 6:00 on Sunday morning or of articles buried in the back pages of the local newspaper. These are, however, unimaginative uses of the mass media and may not be at all suited to implementing curricula.

There are other ways to use mass media technology to provide people with information. Teleconferencing allows you to link people at many different locations with a resource person--a noted authority in the area, an administrator who has carried out the curriculum innovation planned, or an eloquent advocate who can speak convincingly about the needs being addressed. Or, your institution's staff could participate in a conference call linking several authorities, advocates, or institutional staffs and could benefit greatly from the interchange between these resource persons.

The telephone, as a medium of information, has the great advantage of relatively low cost. The expertise of others is available for only the cost of a conference call. The medium allows the resource person to make a presentation, answer questions from listeners, and discuss issues in seminar style with other resource persons. A conference call can be combined with a multimedia presentation; for example, if one of the participants wishes to use slide presentation, it can be shown to an audience while he or she reads the accompanying script during a conference call.

The electronic blackboard is another medium that can be used to provide information. This technique is more expensive than teleconferencing because of the equipment required to send and receive. If such equipment is in place, however, audiovisual materials presented via the electronic blackboard can be a valuable supplement to the presentations or discussions of the teleconference.

Likewise, satellite communications might be available to inform people in the institutional district. Many universities transmit television programs that may be pertinent to the curricular innovation being implemented. If the budget allows, an agency might develop a tailor-made program. Videotapes or videodiscs also are available to provide needed information. It may be desirable to produce a videotape to provide the specific information needed.

Finally, computer networks are an increasingly important means of communicating information. Electronic newsletters that provide information about programs, products, resources, meetings, or research projects that could be of help in the implementation effort. Electronic mail systems, such as the ADVOCNET network sponsored by the Office of Vocational and Adult Education, U.S. Department of Education and operated by the National Center for Research in Vocational Education, offer quick and easy access to many individuals and agencies. Information, advice, and technical assistance services may be obtained by use of these systems.

Persuasion

Persuasion involves another set of techniques useful for convincing people to make changes. Unlike information techniques, which largely rely on passive participation of other people, persuasion techniques tend to involve other people actively. In fact, it is this active involvement that often makes other people aware of their own stake in the issue and persuades them of its legitimacy and appropriateness.

Some persuasion techniques allow for an active interchange between people. In a personal interview, for example, a flow of information is established. The listener becomes a participant who can react to what is being said, can voice concerns, can point out potential problems, and can identify possible solutions. This has the great advantage of giving the other person some voice in the change being implemented.

Other persuasion techniques involve people actively in the design, planning, or execution of change. For example, once instructors are made aware of the need for articulation across areas and levels, working groups could begin the development of an articulated curriculum. As each group sets out to accomplish its assigned task, the members of the group come to feel a sense of ownership in the product they are developing. By the time the groups complete their development, they are likely to regard their recommended curriculum as a product of their own thinking and efforts. They could easily become the most ardent and effective advocates of the process as they now understand what can be done with such materials and what characteristics the materials should have.

Case in Point: Incentives

Some persuasion techniques that can result in active involvement of people in the change process contain an element of incentive for the participant. Such incentives may range from the concrete and tangible (e.g., additional pay staff receive for undertaking additional duties) to the intangible (e.g., the sense of pride in accomplishments).

For many people, recognition by their profession is a strong incentive for performance. Public recognition of instructors' or administrators' progress toward implementing changes can provide powerful motivation for others to make similar progress, in addition to reinforcing a sense of pride in work and satisfaction in those who are recognized. An institutional newsletter can provide a vehicle for recognition, as can an administrative meeting or inservice activity. Some token of recognition, such as a certificate, plaque, or letter (to be placed in the person's personnel file) is a good motivator. Less enthusiastic innovators also may become motivated to greater effort when they see someone recognized in this matter.

The prestige lent by an established authority's endorsement of an innovation also can be a strong incentive for many people. For many individual instructors, the support of an administrator for a particular improvement is often a great persuader. For others, the opinion of university researchers or exemplary practitioners may tip the scales in favor of proposed changes. Likewise, individual instructors are often highly respected opinion leaders throughout an institution; an endorsement by such instructors could have a powerful effect on the opinions of their peers. Opinion leaders and advocates from the local community could have the same effect on practitioners.

Finally, a structured and orderly approach to planning and implementing improvements can be an incentive to participation for some people. Resistance to change is often the result of the uncertainty it creates. We are all creatures of habit to some extent; we may accept relatively easily the fact that a particular need exists yet balk at the changes required to meet that need. A familiar routine threatens to become an unknown.

Such apprehension often can be eased by the introduction of structure into the change process. Differentiated staffing assignments could be made, for example, different groups could each be made responsible for specific parts of planning or implementation; a specific administrator could be assigned as coordinator of the process and resource person for working groups; clear lines of communication and authority could be established. Likewise, instructors and administrators could be prepared for the part that they are to play in the improvement process through a regular, formalized staff development program. All of these structure help people by providing them with a cast of characters and a script to follow in their efforts. They help to make the unknown known and the uncertain certain.

Direction

The final set of techniques--directive techniques--should be used as a last resort in effecting change. These techniques are usually the least productive approach to implementing innovations. Although people can be forced to do specific things, this does not influence them to view those things as justified and desirable. Consequently, the wholehearted cooperation that is essential for an innovation to succeed may be absent.

With these cautions in mind, an administrator may establish deadlines for completion of particular tasks. They must be realistic and somewhat flexible, but firm.

When used realistically, deadlines have benefits. First, they help get tasks completed--tasks that, without some sort of time pressure, could easily be postponed from one day or week or month to the next. Second, some people discover, once they are pressured into working on a task to meet a deadline, that they don't really oppose the change being implemented after all. When they get involved, they may come to see its appropriateness. Third, deadlines are the impetus for decision making--achieving closure on good ideas that otherwise might be lost to the institution. This provides a sense of accomplishment.

Another directive technique is the fait accompli, in which a decision is made and implemented without others' knowledge and presented to them as an accomplished fact. Although people react unfavorably to this, some situations may make it appropriate. A committee of instructors or administrators, for example, might be unable to reach agreement on recommendations to be made. If this deadlock persists, it may become necessary for someone with authority to impose a decision.

Probably the ultimate in directive techniques is strategic replacement of

staff. Those people who continually resist innovations are dismissed or transferred and replaced by others sympathetic to proposed changes. Although this technique removes resistance, it is not always easy to carry out and can adversely effect employee morale. Other teachers and administrators may not have agreed with the stance of the individual who was replaced, yet they might resent what appears to them to be unfair treatment. If the person replaced is popular or an opinion leader, others might react strongly. The use of this degree of force does, however, help to demonstrate the inevitability of the changes being implemented.

Case in Point: Legal Mandates

One final directive technique is the authority of a legal mandate. Such mandates may come from within the institution or from state or federal legislation. The Carl Perkins Vocational Education Act of 1984, for example, mandates increased cooperation between the public and private sectors in preparing individuals for employment. Mandates also can arise from court decisions whose effects are generalized to all institutions, or from governmental administrative agencies whose funding or reimbursement policies dictate compliance with given policies.

Implementing a legal mandate sometimes causes less negative reaction among staff than those directive techniques that originate within the institution. People may disagree with the mandate yet not resist enforcement.

Another advantage of the legal mandate is that it often establishes specific expectations and deadlines; it may describe in some detail just what is to be accomplished and when. Often, however, such clarity is lacking in mandates. Mandates sometimes result in minimal compliance.

Instructors, themselves, may be resistent to curricular changes. One way to minimize this resistence is to provide opportunities for technological update. The following section discusses strategies for updating teacher skills.

Strategies for Updating Teacher Skills*

Instructors often reduce their resistance to changes in curriculum by updating their skills in the technology involved in the innovative curriculum. Technological update refers to the acquisition of technical (as opposed to pedagogical) knowledge and skills needed to provide their students with up-to-date preparation for the current technology of the occupation involved. Various means may be undertaken to achieve technological update. Six delivery techniques for technological update are as follows:

- Work experience internships
- University and college course work
- Workshops, conferences, and seminars
- Industry observation and visits
- Education and industry staff exchange
- Part-time employment

Work Experience Internships

One promising approach to the provision of technological update for vocational-technical teachers is the work experience internship. The approach is used by a variety of vocational education

*Excerpted and adapted from *Updating Teachers for Tomorrow's Technology: Programs and Practices* (Wonacott and Hamilton 1983, pp. 1-32).

institutions under a variety of names--occupational experience, return to industry, industrial leave, occupational renewal, and others.

Administrative Characteristics

The work experience internship has several typical characteristics:

- Instructors return to perform actual work in business or industry in their own fields.

- Specific objectives that instructors are to achieve often are determined in advance of their actual return to the work place. In some postsecondary institutions, instructors must justify their choice of objectives to be achieved by specifying how those objectives will be incorporated in future instruction.

- Businesses or industries to which instructors return typically are required to provide work experiences that will allow the achievement of the instructors' specified objectives.

- Instructors' progress and performance in the work experience internship are likely to be reported and evaluated. Reporting and evaluation are most often informal and may be performed by the participating instructors, a supervisor or administrator of the postsecondary institution, or a supervisor in the business or industry.

- Internships commonly last from 1 to 10 weeks. Some institutions do make provisions for longer work experience internships--up to 1 year, for example. Longer work experience internships, however, typically require that the instructor be granted extended sabbatical leave.

- Usually, provision is made so that instructors suffer no financial loss through participation in work experience internships. Often, the postsecondary institution continues the instructors' regular salary during the internship; such a continuation usually carries a stipulation that the instructors receive no salary or wages from the business or industry providing the experience. Another possible arrangement is for instructors to receive pay from business or industry but consign the pay to the institution while remaining on regular instructional salary. Internships carried out on the instructors' own time (e.g., during holiday or summer vacations) do not affect their regular teaching salary.

- More often than not, instructors are given released time from teaching duties to participate in work experience internships. If so, the institution provides substitute instructors for the period of the internship. Although this released time can be provided under a traditional sabbatical leave policy, it is more commonly governed by other policy statements. Some institutions, on the other hand, make no provisions for released time from teaching duties, requiring instructors to participate in the internships on their own time. In exchange for released time, some institutions require a commitment from the instructors to return to teaching duties for a specified period of time after the internship (e.g., 1 year).

- A program of work experience internships usually is implemented at the local level by the postsecondary institution. Less common are internship programs operated by state departments of education or teacher education institutions. Local programs tend to be administered less formally than those having wider geographic impact.

Although work experience internships share some characteristics with other approaches to providing technological update, certain constants differentiate them from such other approaches. They differ from business and industry observations in the nature of the experience provided to the instructor. The work experience internship necessarily involves actual hands-on work with the technology of the workplace, leading to the development of discrete skills in the technology. Observations, on the other hand, provide only for the development of knowledge of the technology (and are usually of shorter duration).

Likewise, work experience internships differ from summer employment of teachers in business and industry. Whereas an internship is typically carried out during released time from instructional duties, summer employment tends to be ungoverned--teachers seek it on their own initiative and in their own way, participate in it according to their own ideas and for their own purposes, and are accountable only to themselves for their progress and performance in acquiring new technological knowledge and skills.

Advantages and Disadvantages

There are both advantages and disadvantages to the use of work experience internships in providing technological update for vocational-technical teachers. Among these are the quality and nature of instruction provided to teachers in the technology. The nature of instruction is potentially the greatest advantage, while the quality of instruction, in individual cases, can be a disadvantage.

The nature of instruction available to teachers in work experience internships is, at least potentially, of high quality. In an internship, the teacher has the opportunity to learn from the best possible source--those who work with and use the technology closely and daily. Workers and supervisors who are in constant and immediate contact with the technology are most likely to have the knowledge and skills that the teacher is seeking to acquire.

Furthermore, the instruction available in an internship can be intensive, sustained, and comprehensive for the teacher. Released from the daily concerns of teaching duties and assigned to a regular work station in business or industry, the teacher has the opportunity to focus his or her entire attention on the task at hand. During a long internship, the teacher can acquire knowledge and skills in numerous areas of the technology--different pieces of equipment, different functions of the technology, different areas of technology, and so on. Finally, instruction can cover not only knowledge of the technology but also hands-on skill in it as well.

The quality of instruction provided in work experience internships, however, can be more problematic. Often, supervisors and workers in business and industry offer high-quality instruction to teachers in internships. Many schools and colleges report high levels of satisfaction by teachers and administrators with the instruction provided in internships. Doubtless, many business and industry supervisors have had enough experience in training new workers to be quite effective in helping teachers acquire the knowledge and skills they need.

The fact remains, nonetheless, that most work experience internships are rather loosely supervised and reviewed. No matter how well intentioned the participants, it is possible that efficient and effective instruction will not be offered in a given internship. Since business and industry personnel are not educators for the most part; there is always the chance that a teacher will not be taught in a way that allows him or her to learn effectively.

Another obvious disadvantage of work experience internships carried out during released time is the need to use substitute teachers. This comment is not meant as a reflection on the expertise of substitute teachers. However, students confronted

with a change of teachers in the middle of a term must adjust to the new individual and the individual's style of teaching and interacting. Such an adjustment is hardly likely to halt progress in the classroom and laboratory but does constitute a disruption in the routine of instruction, temporarily slowing progress. In high-technology areas, furthermore, adequate substitutes often are not available.

University and College Course Work

Perhaps the most commonly cited approach to providing technological update to vocational-technical teachers is traditional university or college course work. Many instructors and administrators originally acquired their own professional pedagogical training using this approach, so it has been only natural to extend the use of the approach to the provision of technological update.

Administrative Characteristics

A program of university and college course work for technological update characteristically functions in the following manner:

- Instructors enroll for selected undergraduate or graduate courses at a college or university. The courses usually are an established part of the curriculum.

- The process of selecting courses to be taken varies widely from one situation to the next. At one extreme, individual instructors select courses entirely on their own initiative and at their own convenience and expense to suit their own taste. At the other, instructors must justify the course selection to their institution's administrator by demonstrating its relevance to the program curriculum and its potential for improving instruction to prepare students for the world of work. Between these two extremes lie numerous variations in the extent to which this approach is regulated and monitored by educational authorities.

- Although instructors generally enroll for courses during nonteaching hours (i.e., evening hours or summer vacation), some institutions do provide released time from teaching duties for teachers to pursue course work. In its most extreme form, this released time is provided as sabbatical leave, usually reserved for long-term, degree-oriented course work.

- Instructors' progress and performance in university or college course work usually are not supervised or monitored closely. When postsecondary institutions reimburse instructors for tuition expenses, they generally require only proof of payment and successful course completion, success being typically defined in terms of letter grades. When university and college courses are nonreimbursed professional development activities, proof of successful course completion is usually the only requirement.

- The focus of course work is likely to be less well defined than that of other approaches to technological update. As is often the case with courses at any level, instructors and administrators tend to think in terms of topical areas and very general learning objectives. An institution that requires instructors to justify other update activities by stating precise objectives for the activities is often likely to be satisfied simply with a course title as justification for this activity.

One basic feature differentiates this approach from a bona fide university update program. As explained previously, instructors generally assess their own needs for course work informally and on their own initiative. A university update program,

however, usually has a more formal needs assessment component, ensuring that the update activity is appropriate to the teacher's needs and will result in improved instruction. A university update program is very often an ad hoc effort to address specific perceived problems in an entire geographical area or occupational program area. In the course work approach, on the other hand, instructors often simply open the regular course catalog and browse until they find something that seems interesting and pertinent to them personally.

Advantages and Disadvantages

There are two potential disadvantages to university and college course work as an approach to technological update of vocational-technical teachers. One of these is the level of expertise available among university and college faculty. The second is the appropriateness of this activity to teachers' specific update needs. One advantage is the information resources of faculty.

Although it is no doubt true that many individual university and college faculty members are in touch with the latest technological developments of their fields, some question remains as to whether universities and colleges are the best source of current expertise for postsecondary instructors. Some university and college faculty members may be in the same situation as their postsecondary colleagues. Sometimes, these faculty members have been away from the workplace for as long as postsecondary teachers. They may have had little or no more opportunity to experience firsthand the effects of new technology on day-to-day work than teachers seeking update.

The appropriateness of university and college course work to teachers' update needs is also sometimes questionable. University and college campuses often have the same financial limitations as postsecondary institutions; as a result, the physical plant (e.g., tools, machinery, equipment) may be no more up to date than that of the teacher's home institution. While this would not prevent teachers from acquiring knowledge of new technology, it would prevent their acquiring hands-on experience in the operation of that technology. Appropriateness, then, would depend on the individual teacher's own need for update. Those seeking knowledge of new technology might do well to enroll in university and college courses, whereas others in need of hands-on experience might be inadequately served by the approach.

The advantage of this approach to technological update, on the other hand, is the great potential of university and college faculty to act as information brokers. While their own personal expertise may not be sufficient to meet individual teachers' update needs, the very nature of the faculty members' role in the educational community often equips them admirably as linking agents between those who need current expertise and sources of that expertise. They should be able, with the entire resources of the university or college at their disposal, to tell teachers how to go about updating their knowledge and skills. Often, faculty members can put teachers in touch with the standard information resources of the educational community and the technology of their own area. Further, they frequently are able to identify personal contacts in the local business, industry, or education community who can share the latest technological knowledge and skills with vocational teachers. This role of resource broker is perhaps the most important one to be played by university and college faculty in technological update efforts.

Workshops, Conferences, and Seminars

Workshops, conferences, and seminars have become widely popular and used for staff development and training purposes in many business, industry, and education settings. Vocational-technical educators and administrators very often share this general enthusiasm, which results in the frequent use of workshops, conferences, and seminars as a means of providing technological update to vocational-technical teachers.

In most instances there is no perceptible difference between a workshop and a conference and a seminar--nomenclature appears to be highly individual and a matter of taste. Hence for convenience' sake, the term workshop will be used for the remainder of this discussion.

Administrative Characteristics

There can be great variation in the way individual schools, colleges, and districts implement workshops as a means of providing technological update. However, the following general characteristics are typically discernible:

- Instructors attend relatively short training sessions targeted specifically to content and to audience (e.g., a workshop on electronic ignitions for automotive instructors). The length of these training sessions varies from 1 day to 1 week. Longer workshops do occur but are relatively uncommon.

- Subject matter experts are typically used as instructors in workshops. Very often, current workers or supervisors in business or industry are brought in as consultants to give workshops. Given the source of expertise tapped in this approach, the instruction provided usually is perceived as quite up-to-date and pertinent to the participants' needs.

- Although many workshop activities are informational in nature, giving teachers up-to-date knowledge of technology, there is often considerable emphasis on hands-on activities and development of specific technological skills. In many instances, actual items associated with the technology (tools, machinery, equipment, and so on) are made available for skill development. Thus, in spite of the limitations imposed by the short duration of workshops, instruction can be thorough and intensive in the targeted content.

- In some cases, a formal program of workshops is organized and offered by an education agency--college, teacher education institution, state department of education, or professional organization. In these cases, the sponsoring agency generally conducts a needs assessment to determine the content to be covered. The extent of the needs assessment is dictated by the interests of the sponsoring agency: a state department needs assessment usually includes all postsecondary instructors in the state and a professional organization would poll its entire membership, whether that be local, state, or national.

- In other cases, no formal program of workshops exists. Rather, teachers are simply urged to identify and attend workshops appropriate to their own needs and on their own initiative. This encouragement of workshop attendance may be formally and forcefully stated in, for example, a professional development policy. It also may be given informally in casual personal interaction between administrators and teachers. Whether encouragement is formal or informal, however, careful needs assessment outside a specific program of workshops tends to be neglected. Although many teachers are no doubt quite conscientious in selecting and attending appropriate workshops, there often is no mechanism for monitoring teachers' choices and ensuring that they will result in the specific improvement in instruction required to prepare students for the world of work.

- Frequently, provision is made for released time and reimbursement of expenses for workshop attendance. Such provision may be one component of a formally organized program of

workshops. State department of education workshop programs, for example, may include funds to reimburse teachers for travel expenses and to reimburse institutions for substitute teachers, allowing attending teachers to be given released time. These reimbursements are often automatic in such programs. On the other hand, provision for released time and reimbursement of expenses may simply consist of a general professional development policy statement in which the workshops are listed as one of a number of activities similarly treated. In such cases, the ability of the institution actually to provide money and time for teachers to attend workshops depends on availability of funds.

- Workshops may be brought into a given institution, or teachers may travel to the workshops. When a formal program of workshops is organized by an institution, the workshops usually are given on-site. Workshop programs organized by teacher education institutions, state departments of education, or professional organizations usually are given at one or more central locations relatively accessible to all prospective participants in an effort to equalize the time and cost required to travel. Of course, there are no generalities to cover the location of workshops selected and attended by teachers on their own initiative.

It is helpful to differentiate workshops from one other approach to technological update--industry training or updating programs. Like workshops, industry training and updating programs are relatively short training sessions specifically targeted in terms of content and audience. However, industry programs are even more specifically geared to content than general workshops, usually focusing on a specific product or products manufactured by the business or industry involved. Furthermore, the intended audience for industry programs is mainly business and industry personnel, not educators. Although many such training programs gladly accommodate vocational instructors, their primary concern is the knowledge and skills of their own in-house staff.

Advantages and Disadvantages

One significant advantage of workshops is the nature of instruction available to vocational-technical teachers in need of update. Such instruction usually is (and is perceived to be) very specific in nature and oriented to the development of skill as well as knowledge. The specificity and dual dimension of the instruction offered have the advantage of focusing teachers' attention more closely on their own specific objectives in attending the workshops. Thus, it is more likely that the activity will give teachers the opportunity to gain the particular knowledge and skills related to the latest technological developments in their fields.

A further advantage of workshops is that they typically tap one of the best possible sources of expertise--business and industry personnel involved in the daily application of technology. This helps to ensure that the instruction available in workshops reflects the actual practice and application of the technology in the specific field. Who could know better what knowledge and skills are required for the latest technological developments than someone who is involved with those developments every day?

There is, however, one disadvantage to the use of workshops as an approach to technological update. The relatively small amount of time spent in a workshop means that only a relatively small amount of content can be covered. While this disadvantage can be minimized by implementing a comprehensive program of workshops, the fact remains that a single workshop may provide only partial coverage at best.

Industry Observation

Visiting and observing business and industry sites is a commonsense approach to updating knowledge and skills in new technology. Logic indicates that one excellent way of finding out what the technology of a field is and how that technology works is to go into the workplace and see it.

Administrative Characteristics

This approach to technological update of vocational-technical teachers commonly functions in the following manner:

- Instructors visit a business or industry site employing workers in the occupations for which they train students. At the site, instructors observe new technology in place and in operation. This allows instructors the opportunity to identify the knowledge and skills needed to prepare students for the technology of the world of work.

- Industry observations tend to be of short duration, lasting from 1-5 days.

- The selection of sites to observe is generally informal and loosely controlled. Instructors largely use their own judgment, experience, and knowledge of local employers, often with input from advisory committee members, to identify appropriate sites to visit.

- Instructors may or may not be provided with released time for industry observations. Some institutions are willing and able to pay for substitute instructors, allowing the visiting instructor to carry out the observation during normal teaching hours; others require instructors to observe on their own time--during evenings, weekends, or vacation. Reimbursement for travel also varies.

Industry observation differs from work experience internships in the length and nature of the experience. Observations are of shorter duration than internships and hence do not allow for the acquisition of as much content. Furthermore, observation provides participating instructors the opportunity only to acquire knowledge of new technology and its application and use in the work place. Instructors do not go on to develop skill in using the technology themselves, as in the case in work experience internships.

Advantages and Disadvantages

The advantage of industry observations is that they give instructors a firsthand look at technology in place and in operation in the world of work. Instructors can acquire knowledge about technology and its use from the best possible source for their purpose--the actual business and industry sites at which their students hope eventually to be employed. It would be difficult to overstate the importance of this factor to instructors seeking update of their technological knowledge and skills.

On the other hand, the nature of the activity limits its effectiveness in providing update to instructors. While observation may provide instructors with knowledge of technology and its use from the best possible source, its usefulness ends there. It does not allow instructors to develop skills in the operation and use of the technology in question. This limitation may be acceptable to some instructors--that is, those who need only to teach their students about technology. It cannot, however, be acceptable to any instructor whose students themselves need to acquire up-to-date technological skills required in the world of work.

The relatively informal and loose control of site selection for industry observation can be a disadvantage in the use of this approach. Many teachers will, of course, formulate their own specific goals and objectives for an observation and

ensure that the site they select will allow them to meet these goals and objectives. However, others will tend to think in general and unspecific terms when selecting a site; the general lack of administrative checks often allows this lack of focus, resulting in the possibility that teachers observe sites and practices that are minimally relevant to their own update needs.

Education and Industry Staff Exchange

One means of providing technological update to vocational-technical teachers is an exchange of personnel between postsecondary institutions and business or industry. The teachers involved have the opportunity to reenter the workplace and gain needed technological knowledge and skills; the business or industry personnel have the chance to teach a vocational course. All sides can benefit from such an exchange of staff.

Administrative Characteristics

An education and industry staff exchange has several typical characteristics:

- As implied in the name, the first characteristic of a staff exchange is the exchange of personnel between a postsecondary institution and a business or industry. The teacher assumes the job position of the business or industry person, actually performing the functions and duties of that job, while that person takes over the teaching duties of the teacher.

- Once the exchange of staff has been set up, each person involved actually does the work of the other. The teacher performs the functions and duties of the industry position he or she is filling. The industry person actually teaches in the program of the participating teacher.

- Each employer--the institution and the business or industry--undertakes the responsibility for providing the exchange personnel with the opportunity for meaningful involvement in its own operation. These undertakings often are expressed in formal written agreements between the two employers. One feature of such agreements is frequently a promise by the business or industry to allow the participating teacher access to production technology and a promise by the teacher to respect the confidentiality of such information. Also, such agreements usually address legal concerns associated with the exchange--the effect of contracts with labor unions, licensure and safety issues, and liability insurance coverage, for example.

- Arrangements are generally made in each individual case for continuation of salary and benefits for the personnel involved in the exchange. The most common practice seems to be that each original employer continues to pay the regular salary and benefits of its own employee, provide worker's compensation coverage, and so on. Each employee officially remains an employee of the original employer, while being treated fully as an employee at the exchange site. Generally, the exchange between the two employers is one of services only.

- This exchange of personnel between postsecondary institutions and business or industry can last from 2 weeks to an entire academic quarter. In general, the length of a given exchange is fixed in the agreement between the two employers.

- Some institutions provide fairly close supervision and monitoring of the exchange experience for their teachers. Practice varies from one

school to the next, but this process can begin with an assessment of the teacher's specific need for updating and the development of stated objectives for the exchange experience. From that point, supervision may extend to visits to the exchange site by an administrator for periodic checks on progress and performance.

- Input is often sought from advisory committee members in identifying business and industry sites with which a staff exchange would be appropriate.

- Since the participating teacher is filling an actual job position at the exchange site, he or she has the opportunity to acquire both knowledge and skills in the technology and its applications. Exchange sites can be counted on to have the necessary physical plant and facilities, since they are engaged in work involving the technology in the first place.

The education and industry staff exchange shares common features with other forms of technological update. Like work experience internships and part-time employment, it involves a return by teachers to the workplace with the object of filling a regular job position and gaining experience in working with the technology in question. All three forms present teachers with the chance to acquire both knowledge and skills. In addition, staff exchanges and work experience internships are similar in that teachers are released from their regular teaching duties for the duration of the activity.

The feature that differentiates staff exchanges from these two other forms of technological update is the exchange component. A vital part of the staff exchange is that the cooperating business or industry sends one of its employees to replace the teacher in his or her teaching duties or some significant portion of them. In this respect, the staff exchange is an instance of a truly collaborative relationship between education and local business and industry.

Advantages and Disadvantages

As with other approaches to technological update that involve return to the workplace, the main advantage of staff exchanges is the nature of the instruction and expertise available to the teacher. The business or industry personnel from whom the teacher acquires technological knowledge and skills are in the best possible position to know the actual functioning of the workplace. Furthermore, the business or industry site will have in place the tools, machinery, and equipment that comprise the technological application. Hence, the activity is well suited to the update needs of many vocational-technical teachers.

An additional advantage of staff exchanges is that they can last long enough for the teacher to absorb a fairly large amount of content in the technology. Even with a short-term exchange (e.g., 2 weeks), the experience is intensive enough to allow the teacher to become well grounded in knowledge and skills related to one segment of the technology.

There is also an advantage for the educational program in staff exchanges. The industry person who temporarily assumes teaching duties may bring specialized technical knowledge and skills to the classroom or laboratory. This knowledge and skill may permit the coverage of content not ordinarily included in the program curriculum, if appropriate. On the other hand, this advantage may be offset by the disadvantage that industry personnel usually have not had training and experience in teaching. There is the further disadvantage that, regardless of the industry person's teaching skills, students must adjust to a disruption in instructional routine--a new teacher with a new style and a new approach.

The quality of instruction in technological knowledge and skills provided to the participating teacher also can be problematic. As noted previously, business and industry personnel are not generally educators; it is simply not their line of work. There is always the chance that a teacher will be unlucky in the assignment of personnel with whom he or she is to work at the exchange site.

Part-Time Employment

It is well known that many teachers assume teaching duties for only 9 of the 12 months of the year. In addition, the 9 month academic year is punctuated by vacations of some length--quarter or semester breaks in postsecondary institutions. Finally, for many teachers, the teaching day is finished by 3 o'clock.

All in all, teaching duties leave many teachers with some amount of time to devote to professional purposes. One use to which this time can be put is part-time employment in business or industry. Such employment in the teacher's own technical field can provide the opportunity for technological update.

Administrative Characteristics

As an approach to technological update, part-time employment usually works in the following manner:

- Teachers identify a business or industry in their own technical field and seek and obtain part-time employment with those employers.
- The part-time employment that teachers obtain takes place during nonteaching hours. This may be during the evening, on weekends, during vacations that occur within the academic year, or during the summer vacation of the 9-month year. Most common, however, is part-time employment during the summer vacation.
- The employment sought is a regular position with the business or industry. The participating teacher functions on the job just like any other part-time employee of the firm, with stated job tasks and responsibilities; teachers receive pay as part-time employees according to company practice and policy.
- The work experience provided in part-time employment is not formally designed as an instructional experience. However, many teachers, in seeking this employment, reveal their motives and purposes--that is, technological update--to the business or industry involved, who then may cooperate with that intent by placing the teacher into an appropriate position. The fact remains, however, that the teachers fill a standard job position, are responsible for the work of that position, and are paid for it. It is in this assumption of the normal role of employee that teachers find opportunity for updating their technological knowledge and skills.
- Depending on the nature of the specific position obtained, the teacher may have the occasion to develop both knowledge and skills related to current technology. In fact, it is more likely than not that the teacher will fill a position that involves both knowledge and skill in technological applications.
- Since part-time employment takes place during nonteaching hours and teachers are paid for their work, teachers are not usually recompensed for their time and effort by educational authorities. Released time is unnecessary; reimbursement for the usual occasional expenses of update activities generally is not offered. By and large, teachers participate in this form of update activity on their own initiative and motivation.

Part-time employment differs from other approaches involving teachers' return to the workplace. It differs from industry observation in the nature of the experience; teachers not only observe but also practice the technology in question in part-time employment. It differs from work experience internships in that the latter are specifically designed as instructional experiences, while part-time employment is only indirectly so; work experience internships also necessitate the provision of released time for the participating teacher and funds for substitute teachers. Furthermore, work experience internships are often a matter of formal written agreement between the cooperating business or industry and the vocational education institution. Part-time employment, on the other hand, is most often entirely between the teacher and the business or industry involved.

Advantages and Disadvantages

The greatest advantage of part-time employment as an approach to technological update is that the instruction provided comes from the best possible source of expertise--an actual business or industry site at which the technology is applied and used. Once again, the particular businesses or industries at which students might eventually be employed are the best places to find out what knowledge and skills students will need and to gain such knowledge and skills.

Part-time employment also provides the opportunity for instruction in either knowledge or skills or both. The source of expertise is good and appropriate; the nature of the site is such that physical plant and equipment are available for practicing the skills required in their use. Finally, the nature of the participating teacher's status at the training site--a regular worker in a regular job position--not only allows but actually requires that the teacher gain the knowledge and skills necessary to do the job.

One disadvantage of part-time employment as a means of technological update is that the content of instruction is dictated by the job position that the teacher is able to obtain. The knowledge and skills that the teacher can acquire will be those used in the particular position. Furthermore, the loose administrative control of part-time employment lessens the likelihood that teachers will carefully and seriously assess their own update needs. All in all, the appropriateness of the content of instruction in part-time employment can be problematic.

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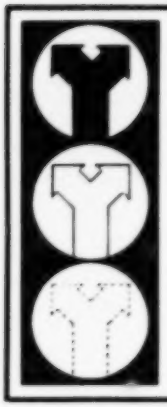


Chapter 8
Monitoring and Evaluating Implementation

Program Evaluation: What Is It? Why Do It? How Is It Done?*

The evaluation of postsecondary vocational and technical education programs has been important since the beginning of vocational education. However, its importance has been amplified with changing financial and economic conditions and with more perscriptive legislation than ever before experienced. With these changes in the import of evaluation have also come changing meanings and connotations for the term. Evaluation to some has been thought of as student assessment, and to others, faculty assessment. To still others, evaluation has brought forth the thought of accreditation through regulatory visitations to institutions and programs. A broad and workable definition of evaluation is as follows:

> *Evaluation* is the collection of information and judgments from a wide variety of sources to facilitate planning, to aid in the improvement of programs, and to meet accountability demands.

This definition provides an umbrella under which many data- or information-gathering activities can be placed, and emphasizes evaluation as a positive, constructive activity.

Purposes of Evaluation

There are many reasons for evaluating educational programs. These vary from meeting external demands to providing information useful to the continuation, enhancement, and improvement of the offerings to students. The following discussion elaborates some of the purposes of vocational-technical program evaluation and answers the question "Why evaluate vocational-technical programs?"

To Improve Programs

One key importance in the definition previously presented is the improvement of programs. This is probably the most important purpose that evaluation can fulfill. Evaluation can help to ensure that instruction is relevant and current, and that planning decisions about program improvement are based upon the best available facts and figures.

To Assist in Making and Justifying Decisions

Decisions that are based upon intuition alone often lead to undesirable

*Excerpted and adapted from *Direct Program Evaluation* (Norton et al. 1983, pp. 1-22).

outcomes, either through actions taken or political consequences. Rational decisions, based upon evaluative information, are defensible and justifiable to program staff, institutional administrators, and supporters of the vocational-technical program. Evaluation can provide information that assists in making decisions about such matters as assignment of personnel, selection of students, program changes, budget allocations, and others.

To Meet Accountability Demands

Evaluation can provide evidence to indicate whether the outcomes of a program are worth the investment. This requires more than a financial summary or audit. It necessitates the presentation of program results (e.g., placement results, achievement scores) in relation to cost information. The audience for accountability reports is usually made up of the supporters or overseers of the program. It might include administrators, boards of control, advisory committees, and other community leaders.

To Promote or Publicize Vocational-Technical Programs

Another purpose for evaluating vocational-technical programs relates to the need to promote programs and keep various constituency groups informed. Similar to accountability reports, public relations reports can communicate evaluation results to the community, faculty, and students. These reports should not gloss over weaknesses; rather, the communication of balanced information can provide a valuable vehicle for gaining and maintaining support for a program as well as for recruiting students. By making people aware of the successes achieved by vocational-technical programs, as well as the shortcomings that the institution is working to overcome, reports of evaluations can help maintain the credibility and advance the image of the college or institution.

Involvement of Significant Groups

To be successful and efficient, the evaluation of vocational-technical programs must involve representatives from numerous groups. Their involvement helps to ensure that the evaluation effort has credibility for various concerned audiences, that important expertise is included, and that the evaluation results are used once obtained. Groups and their representatives might play different roles within the evaluation structure. However, each role is important in helping to achieve one or more of the evaluation purposes outlined previously.

Instructors/Teachers

Instructors should be involved in judging the effectiveness of their own activities as well as those of others. Instructors--whether teaching in vocational education, general education, or other areas--are more knowledgeable about program and course specifications than any other groups. Therefore, they should play a key role in deciding what is to be evaluated and how evaluation will be conducted. Of equal importance, instructors are typically in the best position to make course and program changes. This necessitates their involvement in the evaluation if it is ultimately to result in real change.

Advisory Committee/Council

Advisory committee/council members have made a commitment to vocational education. These individuals have expertise, usually subject-matter specific, that can prove invaluable in the analysis of specific programs and courses. Additionally, advisory committee/council members are in a good position to obtain the cooperation of other community personnel in conducting evaluation activities such as employer follow-up studies, community surveys, or employment demand studies.

Administrators

Administrators must be involved in evaluation efforts. Even if an administrator is not responsible for initiating evaluation activities, an administrator's support and sanction is usually important to the implementation of the evaluation effort. In addition, an administrator can act as an *advisor* to the evaluation process, a *liaison* with other groups or agencies, and a *monitor* of progress. Administrators at all levels play a key role in using the evaluation results; therefore, it is important that they be committed and involved.

Support Personnel

Other personnel such as counselors and placement personnel often have potential for contributing to an evaluation. In addition to having evaluative opinions, these individuals will have expertise and information that is necessary to the process of evaluation. For example, counselors or placement personnel are usually in an excellent position to assist in or direct a student follow-up survey.

Students

For many evaluation activities, students are the most knowledgeable sources regarding actual course and program operations. Students have more contact time with instructors and some support personnel than any other group mentioned. Therefore, their input is critical to an evaluation. Also, students can be involved in the preparation or revision of evaluation instruments such as follow-up questionnaires. For example, having students react to a follow-up questionnaire during its development may alleviate language and interpretation problems that future respondents might have with the questionnaire.

Community Organizations

Some organizations that may be useful to involve in the evaluation are labor unions, industry councils, professional associations, parent groups, and chambers of commerce. Also, public agencies such as CETA, employment service/security commissions, rehabilitation services, and the Veterans Administration could be useful in providing information from their perspective about crucial parts of the environment of postsecondary education. That is, they represent sources of support and are "users" of the "products" of the institution.

External Evaluators

In addition to representatives from the previously mentioned groups, it is often beneficial, although costly, to involve evaluation expertise from private consulting firms, universities, or other agencies. External evaluation personnel can play several roles. First, they can be used to assist in the design and implementation of an internal evaluation system, beginning with the identification of evaluation needs on through the use of evaluation results. A second role involves using an external person as a director of an external evaluation. For example, many special and innovative activities funded by state and federal agencies require that a neutral third-party evaluator be contracted. A third-party evaluator is one who is external to the funding agency and the institution (first and second parties). The external evaluator, in this role, conducts the evaluation and report to both parties.

Focus of Evaluation

A number of focuses for evaluation such as faculty performance, student performance, and others have been mentioned. This section will specify additional focal

points that may be appropriate in the evaluation of postsecondary programs.

The Education Amendments of 1976 (Title II) highlight four areas of evaluation that must be addressed by state boards of education in their evaluation of vocational programs. These include (1) planning and operational processes involving facilities, equipment, services, and curriculum, (2) results of student achievement as measured by competency tests, (3) results of student employment success (placement and wages), and (4) other results as measured by services to special populations.

Additional focal points to consider in evaluating programs can be identified through the review of standards or criteria used by accreditation agencies and state education agencies. For example, one state has conducted extensive research to identify the important components of a successful program. These components are as follows:

- Program management
- Planning and evaluation
- Community resources
- Program content
- Personnel
- Student services

The evaluation of a total program might focus on all of these components.

If an evaluation is to be more specific, focusing on a single course or program, it might consider the following points:

- Students served
- Goals and objectives
- Organization
- Personnel
- Content
- Teaching methods
- Learning achievement
- Supplies, facilities, and equipment

Obviously, the focus of the evaluation will depend upon the purpose, scope, and term of the program. Equally important, the evaluation purpose and scope will dictate the program elements that are to be analyzed or evaluated.

Evaluation Techniques or Processes

Many techniques or activities can be used to obtain evaluative information, formulate judgments, and assist in improving programs. A detailed description of such potential techniques is beyond the scope of this document. However, a brief description is provided.

Student Follow-Up Survey

This activity is designed to help staff gather from former students data concerning the instructional programs and services. Additionally, the student follow-up can help to determine the effectiveness of programs in terms of job placement--a product evaluation measure. A mailed questionnaire, telephone interview, or personal interview can be used to obtain opinions, ratings, and suggestions from former students. The method should be chosen based on the number of students to be surveyed, their geographical dispersion, and the funds and number of personnel available. The survey should be based upon the need for specific program improvement information that will aid in answering broad key questions formulated by staff. It should be planned and coordinated by a team of individuals who represent various groups on the staff. This activity can focus on the total institution, its vocational program, or individual programs or courses.

Employer Follow-Up Survey

This activity is designed to aid in assessing the on-the-job performance of former students. It involves contacting employers to obtain their ratings and comments on the performance of former students. The employer survey can be conducted using a mailed instrument, a telephone interview, or personal interview. Regardless of the method chosen, the information gathered should answer key questions that are formulated by staff. A local leader and a team of staff and advisory committee members should plan and coordinate the survey. This activity can focus on the total institution, a service area, or individual programs or courses.

Student Interest Survey

This activity is designed to facilitate the collection and use of student career interest information. This may involve the use of standardized interest inventories or locally developed instruments. Interest information is used in two ways: (1) to aid in student career planning, and (2) to aid in curriculum and program planning. Teachers, counselors, curriculum specialists, and students should be involved in this activity. The activity may be conducted for the total student body or certain instructional levels, or individual instructors may choose to use it independently within their classes.

Evaluation of Instructional Materials

This activity, may include three phases that are designed to improve the collection and use of materials. These phases are as follows:

- The inventory of all instructional materials that are owned by the institution
- An assessment of the adequacy of the materials
- The utilization of the results of phases one and two to increase the use of materials and also to aid in the selection of new materials

A combination of methods--including the survey, staff rating of materials, and student rating of materials--is possible. A local leader (possibly a media director or librarian) should be appointed to direct a team of instructional and support personnel in this effort. The activity is designed primarily for assessing the institution's entire collection of instructional materials, although it can be adapted to focus on certain segments of the collection, such as the audio-visual media available.

Team Evaluation

This activity involves the use of a team of educators; business, industrial, and labor representatives; and former students to analyze the total program or its various components. This review process involves two teams of individuals: one to plan the activity and prepare materials, and the second to actually conduct the review. The review team observes the facilities, interviews personnel, and studies available information in an attempt to formulate conclusions about the program and to suggest ways of improving identified deficiencies. The purpose of the review team is to provide consultant assistance that includes suggestions for improvement. This activity can be applied to the total institution, a service area, or individual programs and courses.

Student Testing

This activity, in which all instructors are already involved, stresses the use of student test data in a program evaluation. The activity involves the development of instruments and measurement techniques to assess the achievement of various forms of student performance objectives

within the cognitive, affective, and psychomotor domains. It also involves the preparation of individual and group profile forms that can be helpful in using the results. Instructors should assume the primary responsibility for completing this activity, and cooperation among instructors who teach the same courses or subjects should be encouraged. The activity can be done by all instructors, or individual instructors can use it independently.

Evaluation of Community Resources

This activity is designed to aid in the evaluation of the availability and effectiveness of community resources such as prospective advisory committee members, guest speakers, and field trips. The activity has two parts. Part one focuses on the identification of available resources through the use of a mailed questionnaire or a telephone survey. The result of part one is the establishment of a resource file or catalog. Part two focuses on the rating of the effectiveness of these resources by students and staff through the use of a printed questionnaire or rating scale. The results of part two can be incorporated into a resource file and used to improve the selection of outstanding resources. A team of individuals--consisting of administrative staff, instructors, and advisory committee members--should coordinate the activity. If possible, this activity should be applied to the total institution or college, however, it can be applied to any instructional component of the institution or college.

Student Evaluation of Instruction

This activity is designed to aid staff in obtaining information from current students to facilitate the improvement of classroom instruction. In order to determine instructional effectiveness, a team of staff generally develops a questionnaire or rating form that is administered to currently enrolled students. The questionnaire results are then summarized, and each instructor (with support from others) prepares a report that includes suggestions for improving the instructional process. This activity can be conducted for the total institution or college, vocational-technical program, individual programs, or individual courses. Emphasis is placed on the use of results by individual instructors.

Evaluation of Facilities and Equipment

This activity is designed to help in analyzing the adequacy of existing facilities/equipment for the purpose of determining future needs of expansion, renovation, or abandonment. Additionally, this activity can help in increasing the use and improving the safety of facilities. This activity involves the inventory of facilities and the observation and rating of facility characteristics by both advisory committee members and staff members. A local leader and a team of internal staff should plan and coordinate the evaluation and should prepare a report with recommendations. This activity can be applied to the entire institution or college, the vocational-technical program, or individual programs and courses.

Cost/Outcome Analysis

This activity is designed to aid personnel in collecting information regarding costs and relating it to information about outcomes. The activity can focus on the cost/outcome relationships of the following:

- Program
- Course
- Unit of instruction
- Type of media

The results of the activity can assist in making decisions about instructional alternatives and can help increase the efficiency of instruction. One part of the activity involves the collection of cost information from instructional staff members and existing records. Outcome information is gained from existing measures (e.g., test scores, follow-up results, other ongoing evaluation activities, and special data collection procedures). This activity can be applied to the total institution, the vocational program, occupational specialties, individual courses, or more specific components.

Developing an Evaluation System*

The first substantive activity in the design of an evaluation system involves determining and stating the purpose and scope of the planned evaluation system. The purpose for program evaluation may have been determined already by internal staff or by some administrative agency, or it may grow out of a need to make certain planning or management decisions. However, the planning team should formally state the purpose and in writing. The written purpose should state succinctly why an evaluation is being undertaken. This kind of statement, of course, can help in communicating the purpose to others and can aid in alleviating any anxiety or threat that might be posed by the word *evaluation.*

Simultaneous or integral to the development of a purpose statement is the determination of scope or breadth for the evaluation effort. The scope statement, in essence, details what will be included in the evaluation. The planning team may wish to have separate purpose and scope statements, or it is possible--often advantageous--to include both in one statement.

Experience has shown that the evaluation leader should first draft one or more *statements of purpose* and then request that team members react to and revise this draft. Using this approach can save time in accomplishing this task.

The purpose statement in itself is very important to the total direction of the evaluation effort. Therefore, it is necessary to give considerable thought and attention to its preparation. The purpose statements for an evaluation system will vary from program to program or institution to institutions. Some sample purpose statements are these:

- To determine whether stated goals or objectives have been met
- To determine what aspects of the total occupational program need improvement
- To determine needed curriculum content revisions
- To learn what impressions occupational program graduates have concerning the program that they completed

The *scope statement* for the evaluation system is easier to develop than the purpose statement. The scope statement merely indicates which part of the educational or training agency will be involved in the evaluation (e.g., total institution, a single occupational specialty or an individual course). The following is an example of a scope statement:

> The evaluation will focus on the Associate of Arts program in dental hygiene.

By combining and reviewing the purpose and scope statements, the general thrust for the evaluation effort can be determined.

*Excerpted and adapted from *Direct Program Evaluation* (Norton et al. 1983, pp. 35-68).

Develop Key Evaluation Questions for the System

Evaluation questions are broad questions that narrow the focus of the evaluation system *from* the purpose and scope statements *down to* the individual parts or segments of the component being evaluated. Evaluation questions take the purpose statement and make it specific. Evaluation questions reflect what is important to know as a result of an evaluation, i.e., the questions to be answered by the evaluation.

Activities, information sources, and instruments should be selected only if they answer the evaluation questions. This places great emphasis on the need for care and attention to the development of evaluation questions.

Program improvement needs may be the most valuable source for identifying key questions. General concerns or feelings of the staff may reveal some of these, but other sources also should be considered. State or administrative evaluation reports and regional accreditation findings can provide indications of program components that may need further analysis or evaluation.

Exhibit 2 is an outline that will help the evaluation team formulate evaluation questions. These steps may be altered to fit the needs of individual agencies.

Select Appropriate Evaluation Activities

Based upon the selected evaluation questions, it is necessary to determine (1) what data already exist that can be used, and (2) what additional evaluation techniques or activities can assist in providing answers. Data collection techniques include interviews, questionnaires, document review, testing, and observation. It is helpful to use the staff's past experience with certain evaluation activities as a resource in selecting activities. Another alternative is to use the services of an evaluation expert or consultant to assist in the selection of evaluation activities.

In selecting activities (e.g., employer survey), it is essential that those in charge of this process be thoroughly familiar with the nature of each activity, what it is designed to do, what it involves, and when it should be used. Based upon a knowledge of the capabilities of each activity, the focus for each evaluation activity should be redefined. Familiarity with each activity may lead to either a broadening of the focus of the evaluation questions or the specification of further questions. In some cases, the activity will provide information in much greater detail than originally anticipated, and thus, refocusing the evaluation will lead to a more efficient plan.

Identify Leaders for Each Activity

Usually, the members of the planning team will not be able to work directly with all aspects of each evaluation activity. Therefore, it is important that a person (or several persons) be appointed to serve as leaders of each important part of the evaluation process. The leaders should be committed to the goals of evaluation, be familiar with the subject of the evaluation, be able to locate information and resources needed to fulfill their duties, be well versed in evaluation principles, and be respected by others.

Furthermore, these leaders must possess many of the usual administrative skills, such as the ability to organize and complete assignments, work effectively with colleagues, manage time and resources, and express themselves well orally and in writing. In most cases, the leaders will determine their own methods for accomplishing the activities assigned them by the evaluation planning team; considerable liberty can be allowed them with respect to procedures, but the time sequence and deadlines should be adhered to closely.

EXHIBIT 2

OUTLINE FOR FORMING EVALUATION QUESTIONS

1. Build and present a rationale for having key questions.
   a. To focus the evaluation
   b. To aid in selecting evaluation activities
   c. To aid in developing instruments
   d. To aid in using evaluation results

2. Present possible sources of key questions.
   a. Previous evaluation reports (accreditation, state visits, third-party)
   b. Concerns of staff
   c. Planning decisions and needs

3. Secure from other institutions sample lists of key questions and distribute to the team.

4. Duplicate or obtain multiple copies of previous on-site evaluation reports (accreditation, state, etc.) or other informational documents that might help in identifying key questions.

5. It may be advantageous if the evaluation leader highlights some of the priority concerns from any of the three points listed under item 2. This may give the planning team a starting point.

6. Depending on the size of the planning team, as a group or as divided subgroups, write some potential key questions (keeping in mind the overall purpose and scope statement).

7. Later in the meeting or at the next meeting of the team, review several questions and begin discussing each one.

8. The evaluation team will probably have more questions than can feasibly be answered within the resource limits for evaluation. Initially, it is better to have a long list of questions, which can be prioritized later. The team should not be afraid to adapt questions from the examples obtained in items 3 and 4, but should not rely on them entirely. Remember, the evaluation system that the team is designing should meet the institution's specific needs.

9. Duplicate the list of key questions developed by the team. If the list is long, obtain team reaction about priority questions.

10. Prepare a final list of key evaluation questions.

Sequence Evaluation Activities

Once evaluation activities have been selected, it is important to develop a calendar or sequence chart for the evaluation system. This calendar should include an indication of the planned initiation and completion dates for each of the selected evaluation activities. In scheduling, it is often valuable to review resources that provide detailed descriptions of how to conduct each of the selected activities. Through review, the major tasks and subtasks of each activity become clear, and time estimates can be made. A review may also make evident which activities might precede others. For example, when conducting a student follow-up study, the names of employers may be solicited from former students. Therefore, the employer survey might most efficiently follow the former student follow-up survey.

Present the Evaluation System in the Form of an Evaluation Plan

After the purpose and scope statement, and evaluation questions are determined, and evaluation activities are selected and scheduled, all of this information should be transferred to a brief evaluation plan form. Figure 7 is an example of an evaluation plan that includes categories covering the desired information. Once completed, such a plan can be useful in communicating the outline or structure of the evaluation system to everyone. It also provides a general monitoring schedule for the evaluation leader.

The evaluation leader will need to identify those persons or groups (e.g., board, higher-level administrators) whose sanction and approval of the plan are required. Copies of the plan should then be submitted to these persons for approval. The approved evaluation plan should be distributed to all members of the planning and coordinating team, as well as to key individuals in the education or training program under consideration.

Publicity is a factor here, too. It is helpful to arrange for the evaluation plans--once approved--to be announced using local media (newspaper, radio, TV). Community awareness of the need for and purpose of the evaluation effort can help secure cooperation during data collection, and later, when the team makes decisions and changes based on the evaluation results.

Prepare to Implement Evaluation Plan

Each activity listed on the final plan can be further broken down into subtasks. For example, if the plan includes conducting a student follow-up survey, the subtasks would probably include the following:

1. Selecting appropriate persons or groups for involvement and assistance (e.g., advisory council/ committee, students, teachers, administrators, counselors, board members)
2. Determining the best follow-up procedure to use
3. Stating the objectives of the follow-up study
4. Identifying the former students to be studied
5. Designing cover letters, questionnaires, follow-up letters
6. Designing interview guidelines
7. Developing a schedule of activities with time specifications and assignments
8. Conducting the survey
9. Keeping records of survey progress
10. Summarizing, interpreting, and reporting the findings

Purpose:

Scope:

Key Evaluation Questions:

Information Sources:

Data-Collection Techniques:

Schedule of Events:

Activities	Leader(s)	Target Dates	
		Begin	End

Figure 7. Evaluation plan form

11. Implementing approved recommendations

By listing each subtask and then describing it in detail, the evaluation team leader can project the necessary resources and determine who should be responsible for or involved in each subtask.

Staff assignments should, of course, be made for each of the subtasks. The scope and extensiveness of the evaluation activity will dictate the number of individuals needed. The evaluation leader should probably assume overall leadership of all subtasks, though with extensive activities it may be advantageous to also identify individual leaders for each of the subtasks. The evaluation leader can ask for volunteers in situations where no special knowledge is needed or can select individuals when special expertise is required to complete the job.

The next step involves the sequencing of individual subtasks in a configuration that is most efficient in terms of resource and time utilization (i.e., developing an evaluation schedule). Many activities can be conducted simultaneously, but others will have to be conducted in a definite sequence. To initiate this sequencing step, all of the subtasks should be listed, and those that are dependent on preceding tasks should be identified. Then the activities can be placed into a pictorial schedule or PERT-type chart such as the one shown in figure 8 in which subtasks 1, 2, and 3 must be completed before subtask 4 is begun, and work on subtask 2 can be started concurrently with work on subtask 1.

Once activities have been scheduled and sequenced, estimates of time should be attached to each subtask. The example of sequence scheduling presented in figure 8 shows personnel assigned to each of the four activities and projected completion dates for each activity. It often is useful to include the names of those involved. Each of the subtasks may require more than one individual, and the name of at least the leader of the particular activity, or the person responsible for its completion, should be attached to the schedule.

The evaluation team leader will need to ensure that program personnel and all others who will be involved are (1) oriented to the purposes and the procedures of the evaluation activity, and (2) monitored throughout the data collection and summarization processes. It is not enough to merely assign personnel to a given task. These people should clearly understand the thrust of the evaluation so that they can make good decisions as the need arises, adequately explain evaluation goals to others, and comprehend the difficulties that might be met by other personnel. If all members are properly informed, they will be in a position to help one another. This is essential to the success of the evaluation itself.

Finally, once the complete evaluation plan has been developed, the evaluation leader will be ready to implement the evaluation program itself. The evaluation leader should pay particular attention to the schedule of activities drawn up and the relationships of crucial activities such as those depicted in the form shown in figure 8. By being continually aware of progress in terms of these deadlines, the evaluation leader can detect when additional resources (time, money, staff) might be needed to ensure that key activities are completed as planned.

The planning and coordination team should continue to meet primarily to monitor progress and detect and resolve unforeseen problems. The team members should recognize that the original plan developed was probably not perfect in every respect and they may need to modify it in light of changing circumstances. Most of the adjustments are likely to be in the areas of activity schedules or data collection

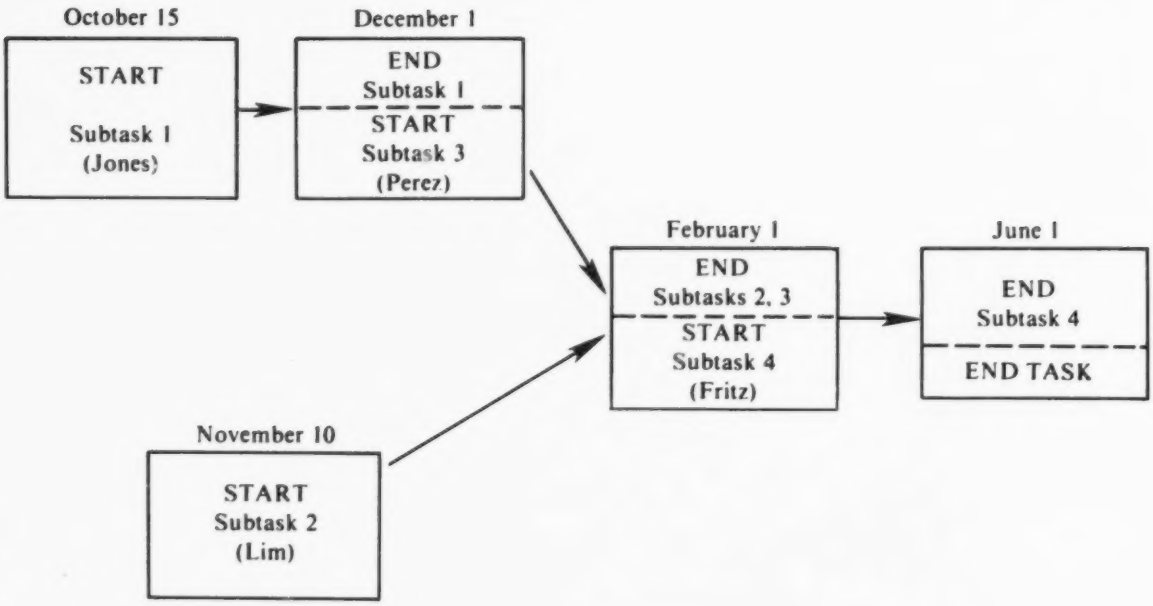
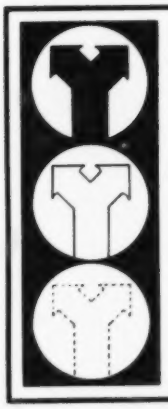


Figure 8. Graphic portrayal of evaluation activity sequencing

techniques. In most cases, the team will retain the original purposes and key evaluation questions that guided the planning. Assuming that the planning was comprehensive, needed adjustments were made in a timely fashion, and the follow-through was thorough, then the data-gathering phase will be successful.



Appendix A Exemplary High-Technology Programs

Exemplary High-Technology Programs*

Introduction

One excellent approach to updating curricula for automated manufacturing technologies programs is to build on the experience and expertise of others in implementing such programs. These exemplary programs in automated manufacturing technologies were identified through a survey of the states and territories. State-level administrators of higher education nominated exemplary automated manufacturing technologies programs operated by community colleges and technical institutes in their states and territories. Staffs of nominated programs were asked to provide program descriptions; programs for which this information was obtained represent the following technical areas:

- Avionics
- Biomedical equipment technology
- Computer-aided design and drafting
- Computer-aided manufacturing
- Computer engineering technology
- Computer numerical control
- Electrical technology
- Electronics technology
- Electromechanical technology
- Graphics technology
- Industrial optics
- Laser technology
- Mechanical engineering technology
- Process control and instrumentation technology
- Robotics
- Semiconductor technology
- Solar technology
- Telecommunications

How to Use This Information

The programs identified in the nationwide survey are presented in a consistent graphic format. As shown in figure 9, a heading at the top of each page identifies the technological area that the program represents. The program title appears in the box at the top of the entry; contact information, including mailing address and telephone number, appears in the box immediately below. Four small boxes appear below the contact

*Excerpted and adapted from *Preparing for High Technology: Model Programs in the USA* (Doty 1985, pp. 3-98).

information; these indicate whether assistance is available, whether a syllabus is available, whether the program is competency based, and when the program was started. Finally, each entry presents a narrative description of the program in the large box at the bottom of the page.

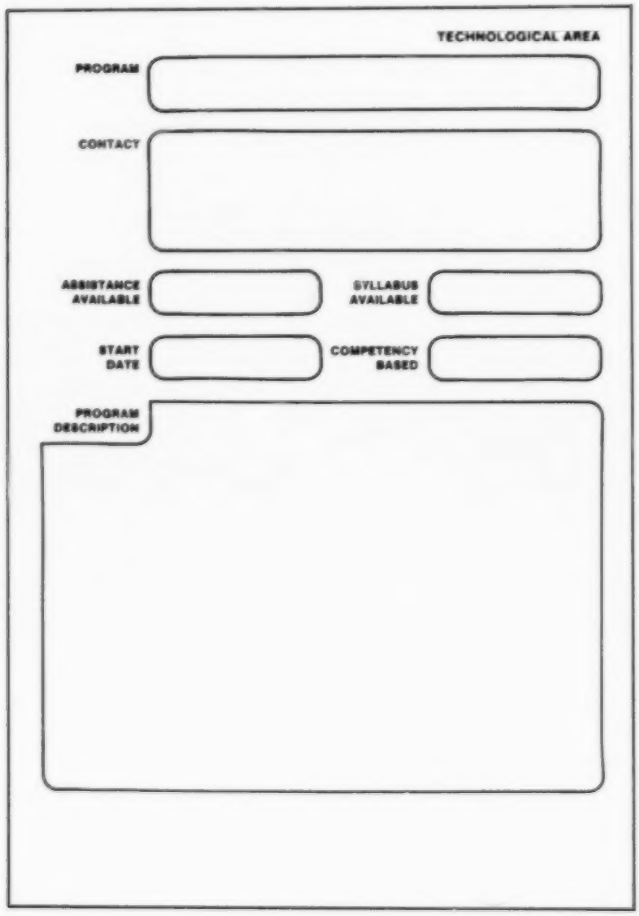


Figure 9. Nationwide exemplary program description format

PROGRAM

Avionics Technician

CONTACT

Goesta Schmidt
Instructor
South Seattle Community College
6000 16th Avenue SW
Seattle, WA 98106
(206) 764-5394

ASSISTANCE AVAILABLE

Yes

SYLLABUS AVAILABLE

Yes

START DATE

1975

COMPETENCY BASED

Yes

PROGRAM DESCRIPTION

The Avionics (Aviation Electronics) Technician Program is a specialized 2-year (6 quarters) training program offering contemporary technology instructional curriculum both in theory and practice. The avionic technician curriculum prepares students to qualify for the Federal Communication Commission (FCC) general class radiotelephone licensing requirements. Associate of applied science degree requirements are as follows:

Technical Specialty Courses

Number	Course Title	Credits
INT 160	Fundamentals of Electronics	8
INT 161	Amplifiers and Oscillators Communication Systems	8
INT 163	Programming for Electronic Technicians	8
INT 116-19	Introduction to Avionics	4
AVT 264	Intermediate Avionics	9
AVT 266	Advanced Avionic Systems	10
AVT 268		10
		57

Continued

Allied Supporting Classes

Number	Course Title	Credits
MAT 111-13	Technical Math	12
PHY 101-03	General Physics	15
		27

General Education Courses

Number	Course Title	Credits
ENG 101-02	Composition	6
ENG 108	Technical Report Writing	3
	General Education Electives (must include one course in social science)	9
		18

Total Credits 102

BIOMEDICAL INSTRUMENTATION TECHNOLOGY

PROGRAM

Biomedical Instrumentation Technology

CONTACT

Springfield Technical Community College
One Armory Square
Springfield, MA 01105
(413) 781-7822

ASSISTANCE AVAILABLE: Yes

SYLLABUS AVAILABLE: Yes

START DATE: 1967

COMPETENCY BASED: Yes

PROGRAM DESCRIPTION

Instrumentation is being used increasingly in medical, biological and research fields. This equipment has become so complex that technicians must have a detailed knowledge of biomedical procedures and biomedical terminology so that proper functioning of the equipment and safety of the patient can be assured. The program provides the general technical knowledge and understanding of the more commonly used biomedical instruments, components, systems, and circuit techniques. The degree of associate in science in biomedical instrumentation technology will be awarded after successful completion of the program requirements.

SEMESTER 1

Number	Course Title	Class	Lab	Credits
LE 100	English Composition	3		3
	Elective: Humanities	3		3
EB 120	Measuring Principles	2	3	3
ET 110	Basic Electronics	3		3
ET 115	Electronics Lab		4	2
MM 101	Mathematics	1		1
MM 102	Mathematics	1		1
MM 103	Mathematics	1		1
MM 231	Engineering Computations	1		1
		15	7	18

Continued

SEMESTER 2

Number	Course Title	Class	Lab	Credits
LE 200	Comp 2: Intro. to Lit.	3		3
EB 230	Measuring Principles	2	3	3
ET 210	Basic Electronics	3		3
ET 220	Active Networks	3		3
ET 215	Electronics Lab		4	2
MC 100	Chemistry 1	3	3	4
		14	10	18

SEMESTER 3

Number	Course Title	Class	Lab	Credits
LE 202	Technical Report Writing (or)			
LE 203	Fundamentals of Speech	3		3
EB 320	Calibration & Standardiz.	1	3	2
EB 340	Electronic Circuits	2	3	3
ET 340	Comp. Architecture and Logic Circuitry	3		3
	Humanities Elective	3		3
ET 350	Electronics Lab 3		4	2
		12	10	16

SEMESTER 4

Number	Course Title	Class	Lab	Credits
EB 410	Bio-Med. Elect. System 392	2	3	3
EB 420	Instrumentation Project		6	2
EB 430	Codes-Laws-Safety	1		1
ED 420	Microprocessor Theory	3		3
MB 136	Applied Physiology	3	3	4
		9	12	13

DRAFTING AND DESIGN TECHNOLOGY

PROGRAM

Drafting and Design Technology

CONTACT

Sam Redding
Chairman
Science and Engineering Technologies Division
Tulsa Junior College—Northwest Campus
3727 E. Apache
Tulsa, OK 74115
(918) 834-5071

ASSISTANCE AVAILABLE

None

SYLLABUS AVAILABLE

Yes

START DATE

1970

COMPETENCY BASED

No

PROGRAM DESCRIPTION

This program prepares the student for a career as a professional drafter. Employment opportunities for those completing the associate degree program include positions such as drafter, checker, layout technician, specification writer, design technician, and laboratory technician.

In addition to general education requirements, the following specialized courses and controlled electives are required:

Engineering — 10 Hours

EGR 1063	Descriptive Geometry
EGR 1313	Manufacturing Processes
EGR 2314	Statics and Strength of Materials

Drafting & Design Technology — 18 Hours

DRF 1323	Basic Drafting
DRF 1333	Intermediate Drafting
DRF 2313	Advanced Drafting
DRF 2333	Special Design
DRF 2363	Electronic Drafting (or)
ELE 1303	DC Electronics
DRF 2373	Computer Graphics

Continued

Controlled Electives 12 Hours

BUS 1313	Employee-Employer Relations
BUS 2363	Supervisory Management
CSC 1202	Computer Concepts AND
CSC 1221	Introduction to FORTRAN OR
CSC 1231	Introduction to Assembly Language
DRF 1353	Architectural Drafting
DRF 1363	Civil Drafting
DRF 2323	Production Illustration
DRF 2343	Process Piping Drafting
DRF 2353	Structural Drafting
MAT 1326	Machine Shop Technology I
MAT 2333	Basic Numerical Control Programming
MAT 2353	Basic APT Programming
SUR 1323	Surveying Problems I
WEL 2413	Welded Pressure Vessel Design

COMPUTER-AIDED DESIGN AND COMPUTER-AIDED MANUFACTURING

PROGRAM

Computer-aided Design and Computer-aided Manufacturing

CONTACT

S.G. Steele
Dean of T.E.C. Division
Director CAD/CAM Center
Broome Community College
P.O. Box 1017
Binghamton, NY 13902
(607) 771-5014

ASSISTANCE AVAILABLE

Yes*

SYLLABUS AVAILABLE

Yes

START DATE

1982

COMPETENCY BASED

Yes

PROGRAM DESCRIPTION

At Broome Community College, computer-aided design and computer-aided manufacturing are integrated into electrical engineering technology, civil engineering technology, mechanical engineering technology, engineering science, and computer science. Required courses are as follows:

		Credits
CAD 200	Introduction to Computer Graphics	3
CAD 201	Advanced Computer Aided Graphics	3
CAD 220	Printed Circuits, Electrical Schematics, and Wiring Diagrams	3
CAD 230	CAD System Operations	3
CAM 210	Computer-aided Numerical Control I	3
CAD 299	Independent Study	

***Technical assistance available:**

- Consultants for colleges implementing courses
- Assistance with short-term training for new personnel
- Tours and demonstrations upon request

COMPUTER MAINTENANCE TECHNOLOGY

PROGRAM

Computer Maintenance Technology

CONTACT

Springfield Technical Community College
One Armory Square
Springfield, MA 01105
(413) 781-7822

ASSISTANCE AVAILABLE: Yes

SYLLABUS AVAILABLE: Yes

START DATE: 1979

COMPETENCY BASED: Yes

PROGRAM DESCRIPTION

The Computer Maintenance Technology Program is designed to provide the students with the necessary electronics background and the computer know-how to deal with the ever-changing computer technology of the space age.

SEMESTER 1

Number	Course Title	Class	Lab	Credits
LE 100	English Composition	3		3
EP 101	Intro. to Technology	2		1
ET 110	Basic Electronics	3		3
ET 115	Electronics Lab 1		4	2
ET 120	Electronic Graphics	1	2	2
MM 101	Mathematics	1		1
MM 102	Mathematics	1		1
MM 103	Mathematics	1		1
NP 109	Human Relations at Work	3		3
		15	6	17

Continued

SEMESTER 2

Number	Course Title	Class	Lab	Credits
LE 200	Comp 2: Intro. to Lit.	3		3
ET 210	Basic Electronics 2	3		3
ET 215	Electronics Lab 2		4	2
ET 220	Active Networks 1	3		3
ED 240	Intro. to Computer Organization & Prog.	2		2
MM 105	Mathematics	1		1
MM 106	Mathematics	1		1
MM 107	Mathematics	1		1
		14	4	16

SEMESTER 3

Number	Course Title	Class	Lab	Credits
LE 202	Technical Report Writing	3		3
ET 310	Active Networks 2	3		3
ET 340	Comp. Architecture and Logic Circuitry	3		3
ED 330	Machine & Assembly Language Programming	3		3
ED 350	Dig. Electric. Lab 1		4	2
EP 320	Data Communications	3		3
		15	4	17

SEMESTER 4

Number	Course Title	Class	Lab	Credits
ED 420	Microprocessor Theory	3		3
ED 450	Adv. Computer Topics	3		3
ED 410	Adv. Digital Elec. Lab		4	2
ET 430	Digital Comp. Systems	3		3
ET 440	Integrated Electronics	3		3
MP 119	Technical Physics	3	3	4
		15	7	18

COMPUTERIZED NUMERICAL CONTROL CONTINUATION

PROGRAM

Computerized Numerical Control Continuation

CONTACT

Charles Granger
Department Head
Greenville Technical College
P.O. Box 5616, Station B
Greenville, SC 29606
(803) 242-3170, ext. 225

ASSISTANCE AVAILABLE	Yes*	**SYLLABUS AVAILABLE**	Yes
START DATE	1983	**COMPETENCY BASED**	Yes

PROGRAM DESCRIPTION

This is a group of nine courses that comprise a continuation of the Computerized Numerical Control Program. This program includes training on creating, editing, and debugging computerized numerical control programs. Students produce tapes with the aid of the computer and practice programming for machine centers and turning centers. Topics covered include the following:

- Circular and linear interpolation
- Tape format
- Turret control
- Constant surface speed
- Proper operating of computer equipment
- Safety

***Technical assistance available:**

- Observation and training

ELECTRICAL TECHNOLOGY

PROGRAM

Electrical Technology

CONTACT

Springfield Technical Community College
One Armory Square
Springfield, MA 01105
(413) 781-7822

ASSISTANCE AVAILABLE: Yes

SYLLABUS AVAILABLE: Yes

START DATE: 1967

COMPETENCY BASED: Yes

PROGRAM DESCRIPTION

The Electrical Technology Program prepares students for work in the development, installation, and maintenance of industrial automated systems. Graduates of the program have also been successful as field representatives for manufacturers in the areas of product application and sales. Students planning to enter this field should have a desire for achievement and involvement in mathematics, science, and technology.

Minimum Grade Requirements: All EE and ET series Electrical Technology courses must be successfully completed with a grade of D or better for graduation. These Electrical Technology courses must be taken in a sequential order. That is, second semester courses cannot be taken until the first semester prerequisite courses are successfully completed as outlined in the Electrical Technology program. Before starting the third semester, the student must have successfully completed the Mathematics Modules MM 105-109. Upon the successful completion of requirements for this program, as listed below, the degree of Associate in Science in Electrical Technology will be awarded.

SEMESTER 1

Number	Course Title	Class	Lab	Credits
LE 100	English Composition 1	3		3
EE 110	Fund. of Electricity 311	3	3	4
EE 120	Engr. Graphics 311	3		3
NP 109	Human Relations at Work	3		3
MM 101	Mathematics*	1		1
MM 102	Mathematics*	1		1
MM 231	Engineering Computations	1		1
		15	3	16

Continued

SEMESTER 2

Number	Course Title	Class	Lab	Credits
LE 200	Comp. 2: Intro. to Lit.	3		3
LE 203	Fundamentals of Speech	3		3
EE 210	A.C. Fundamentals	3	3	4
EE 220	Fund. of Electronics 311	4		4
MM 105	Mathematics**	1		1
MM 106	Mathematics**	1		1
MM 107	Mathematics**	1		1
MM 109	Mathematics**	1		1
		17	3	18

SEMESTER 3

Number	Course Title	Class	Lab	Credits
EE 310	Elec. Cont. for Machines	2	3	3
EE 320	Ind. Electron. Circuits 1	2	3	3
EE 330	Semicond./Transistors 1	2	3	3
ET 340	Computer Conc. & Logic Cir.	3		3
MP 119	Technical Physics	3	3	4
		12	12	16

SEMESTER 4

Number	Course Title	Class	Lab	Credits
LE 202	Technical Report Writing	3		3
EE 410	Ind. Electron. Circuits 2	2	3	2
EE 430	Semicond./Transistors 2	2	2	3
EE 440	Electro-Mech Crt. Design	1	2	2
ED 420	Microprocessor Theory	3		3
EE 450	Oper. Amplifier Circuits	2	3	3
		13	10	16

**Math courses MM 104 through MM 109 must be completed and passed by the start of the third semester.

ELECTRONICS TECHNOLOGY (DIGITAL ELECTRONICS OPTION)

PROGRAM

Electronics Technology (Digital Electronics Option)

CONTACT

Bunker Hill Community College
Rutherford Avenue
Charlestown, MA 02169
(617) 241-8600

ASSISTANCE AVAILABLE: Yes

SYLLABUS AVAILABLE: Yes

START DATE: 1979

COMPETENCY BASED: Yes

PROGRAM DESCRIPTION

The Digital Electronics Option includes courses in electricity, electronics, semiconductor devices, logic circuits, digital theory, electronics fabrication, microprocessor theory, practical circuit analysis, and computer repair as well as English, mathematics, and liberal arts electives.

This intensive program combines classroom work with electronics laboratory experience. Using state-of-the-art equipment, students are able to duplicate the same connections, tests, and measuresments that will be required by an employer. Skilled technicians will find that demand for their abilities is increasing in industry, telecommunications, and medical facilities where they are needed to assist in the design, testing, repair, and maintenance of electronic equipment.

To be eligible for admission to the Electronic Technology Program applicants must have completed through Algebra I and II with a grade of C or better.

First Semester

ENG 102	College English II	3
MAT 191*	Technical Mathematics	3
ETT 103*	Introduction to Electricity and Lab	4
ETG 111	Computer Systems for Electronics Technology	3
	Behavioral/Social Sciences Elective	3
		16

Continued

Second Semester

ENG 103*	College English III	3
ETT 153*	Semiconductor Devices and Lab	4
ETT 155*	Digital Theory and Lab	4
ETG 151*	Programming for Electronics	3
	Behavioral/Social Sciences Elective	3
		17

Third Semester

ETT 203*	Fundamentals of Electronics and Lab	4
ETT 205*	Logic Circuits	4
ETT 207*	Electronics Fabrication Techniques	2
	Liberal Arts Electives (2)	6
		16

Fourth Semester

ETT 253*	Practical Circuit Analysis	4
ETT 255*	Microprocessor Theory and Lab	4
ETT 257*	Computer Repair	4
	Liberal Arts Elective	3
		15

Total Credits 64

*Has prerequisite. See Course Description.

ELECTROMECHANICAL TECHNICIAN

PROGRAM

Electromechanical Technician

CONTACT

Virgil Noordyk
Trade and Industry Coordinator
Fox Valley Technical Institute
P.O. Box 2277
1825 N. Bluemound Drive
Appleton, WI 54913-2277
(414) 735-5783

ASSISTANCE AVAILABLE	Yes	**SYLLABUS AVAILABLE**	Yes
START DATE	1979	**COMPETENCY BASED**	Yes

PROGRAM DESCRIPTION

The Electromechanical Technician Program is a 72-week course of study consisting of six 12-week blocks of time. The program operates on a year-round basis and allows new students to enter at the start of any of these blocks when openings are available.

The curriculum is designed to provide students with a basic electromechanical background. Laboratories are furnished with up-to-date instruments and instructional equipment necessary to gain the expertise and skills to use the tools and diagnostic equipment needed in technical jobs. Instructional emphasis is placed upon the understanding and troubleshooting of electromechanical systems. Upon successful completion of the program students receive the associate of applied science degree.

COMPUTER GRAPHICS PROGRAM

PROGRAM

Computer Graphics Program

CONTACT

Victor G. Langer
Manager of Computer-Based Instruction
Milwaukee Area Technical College
1015 North Sixth Street
Milwaukee, Wisconsin 53203
(414) 278-6247

ASSISTANCE AVAILABLE

Yes*

SYLLABUS AVAILABLE

Yes

START DATE

1980

COMPETENCY BASED

Yes

PROGRAM DESCRIPTION

Emphasis in the Milwaukee Area Technical College (MATC) Programs has been, first, to develop basic engineering skills and, second, to provide computer skills that can solve typical engineering and design problems. Learning how to use computer-aided design as a tool speeds up production. The challenge is to determine how to use computer-aided design as a tool and how computer graphics skills can be integrated into an existing curriculum. Objectives for each course must be analyzed.

In the Mechanical Design Technician Program, computer graphics objectives are integrated into six courses. In addition, two computer graphics courses are offered—an introductory course, that provides computer graphics operational skills and an advanced course designed to assist students in acquiring the skills necessary to apply computer-aided design to mechanical design problems, including three dimensional and descriptive geometry. The basic introductory computer-aided design course is also open to students in electrical technology, civil engineering technology, numerical control, commercial art, printing and publishing, and architectural technology programs.

An advanced course in electrical design includes printed circuit boards, electrical schematics, and other related applications. A new Electrical Design Technology Program now being developed will emphasize, first, the basics of mechanical design, electrical theory, and electrical drafting and then add computer graphic skills and electrical CAD. The Civil Engineering, Architectural Technology, and Commercial Art Departments are developing advanced application courses that are primarily offered as continuing education opportunities or as assignments for regular full-time students.

Continued

Continuing education courses offer an opportunity to test new areas with an industrial group, obtain direction for associate degree programs, and establish a relationship with a community of users. In a departure from engineering applications, computer graphics is being integrated into the telecasting program at MATC's channels 10 and 36. MATC's training opportunities in computer graphics are also being developed in production-related occupations where design databases become accessible for production purposes. The Welding Technology Department is developing instructions for obtaining the maximum number of parts cut out of a metal plate, automated flame cutting, and robotic welding. The Numerical Control Department developed a CAD to CAM interface going from design to actual cutting operations on numerically controlled machine tools. The Electrical Technology Department teaches industrial controls and other automation devices in a move toward computer-integrated manufacturing. The Electromechanical Technology Program is emerging as the basic program for preparing robotic service technicians. The Industrial Engineering Program brings together all CAD/CAM activities for efficient management of manufacturing and industrial processes.

MATC-CAD (TM) was developed at MATC to reduce the cost of design stations permitting use of the Computervision and Cadlinc systems for advanced courses. MATC-CAD is designed to be used primarily as an educational tool for teaching the basic elements of computer-aided drafting in the introductory course. The software is based on an emulation of most of the general two-dimensional capabilities of Computervision's CADDS-3 (TM) graphics system and uses the same student training manual. Hardware includes standard Apple II Plus or IIE microcomputer, graphics tablet, two floppy discs, and a green phosphor monitor with no modifications.

***Technical assistance available:**

- "How to Start Up CAD Training" (brochure)
- "Software and Materials for Interactive Computer Graphics course to Run on an Apple" (brochure)
- Software and materials for computerized machining to run on an Apple (available soon)

INDUSTRIAL OPTICS

PROGRAM

Industrial Optics

CONTACT

Richard King
Instructor
Industrial Optics
Pikes Peak Community College
5675 S. Academy Boulevard
Colorado Springs, CO 80906-5498
(303) 576-7711, ext. 202

ASSISTANCE AVAILABLE

Yes*

SYLLABUS AVAILABLE

Yes

START DATE

1980

COMPETENCY BASED

Yes

PROGRAM DESCRIPTION

This program prepares students to work in the industrial optics industry. Graduates of this program may work in such areas as optics production, testing, or evaluation of optical components and systems. Students may receive a certificate or an associate of applied science degree in this program.

***Technical assistance available:**

- List of equipment required for the program
- Catalog
- Condensed course outlines

LASER AND ELECTRO-OPTICS TECHNOLOGY

PROGRAM

Laser and Electro-Optics Technology

CONTACT

Charles Chrestman
Assistant Director, Program Operations
Itawamba Junior College
653 Eason Boulevard
Tupelo, MS 38801
(601) 842-5621

ASSISTANCE AVAILABLE

None

SYLLABUS AVAILABLE

Yes

START DATE

1984

COMPETENCY BASED

No

PROGRAM DESCRIPTION

The Laser and Electro-Optics Technology Program is a 2-year, associate of applied science degree program. The curriculum is interdisciplinary, with a collection of support, core, and specialty courses. Emphasis is placed on training technicians to operate, test, diagnose, and maintain lasers and other optical devices. Areas receiving the most emphasis are materials processing, communication, medical equipment, surveying, and construction.

MECHANICAL ENGINEERING TECHNOLOGY

PROGRAM

Mechanical Engineering Technology

CONTACT

Donald W. Lavine
Program Advisor
Rochester Community College
Administration Building
Rochester, MN 55901
(507) 285-7223

ASSISTANCE AVAILABLE

Yes*

SYLLABUS AVAILABLE

Yes

START DATE

1949

COMPETENCY BASED

No

PROGRAM DESCRIPTION

The Mechanical Engineering Technology Program began in 1949 as a 2-year associate degree program entitled Engineering Technology and remained so until about 1963. At that time, two new engineering technology programs were implemented: one in civil engineering and one in electronics engineering. As a result, the department changed the program title Engineering Technology to Drafting and Design Technology (with a mechanical and an architectural option). In 1971, this title was changed to Mechanical Engineering Technology. The civil and electronics programs were accredited by ECPD in 1971 and the mechanical program was accredited in 1972. All three programs were re-accredited in 1981.

In 1984, IBM donated two complete Fastdraft systems for computer-aided design and a cash grant to be used to implement a new associate degree program: manufacturing engineering technology with an emphasis on computer-aided drafting, automated systems, robotics, or computerized numerical control machining.

***Technical assistance available:**

- Consultants
- Course outlines
- Curriculum guides

PROGRAM

Instrumentation Technology

CONTACT

Springfield Technical Community College
One Armory Square
Springfield, MA 01105
(413) 781-7822

ASSISTANCE AVAILABLE: Yes

SYLLABUS AVAILABLE: Yes

START DATE: 1981

COMPETENCY BASED: Yes

PROGRAM DESCRIPTION

The Instrumentation Technology Program is designed to prepare students for employment as highly skilled technicians in the broad field of instrumentation.

Instrumentation refers to instruments for sensing changes in heat or pressure, for recording information, or for controlling manufacturing processes that are vital in research, business, space technology, and many areas of industry. Because the instrumentation is so important, there is great demand for people trained to install, calibrate, and maintain the equipment.

Graduates of this 2-year program leading to an associate in science degree may be employed as instrumentation technicians, engineering associates, instrumentation research or process technicans, or instrumentation field service technicians.

SEMESTER 1

Number	Course Title	Class	Lab	Credits
EB 120	Measuring Principles 1	2	3	3
NP 109	Human Relations at Work	3		3
LE 100	English Composition	3		3
ET 110	Basic Electronics 1	3		3
MM 101-103	Mathematics	3		3
ET 115	Electronics Lab		4	2
		14	7	17

Continued

SEMESTER 2

Number	Course Title	Class	Lab	Credits
EB 230	Measuring Principles 2	2	3	3
LE 200	Comp.2: Intro. to Lit.	3		3
ET 210	Basic Electronics 2	3		3
MM 105-107	Mathematics	3		3
ET 215	Electronics Lab 2		4	2
ET 220	Active Networks 1	3		3
IT 120	Graphics for Instr. Tech.	1	2	2
		15	9	19

SEMESTER 3

Number	Course Title	Class	Lab	Credits
IT 310	Control Principles 1	3	3	4
EB 320	Calibration & Standardiz.	1	3	2
MP 119	Technical Physics	3	3	4
ET 340	Com. Architecture & Log. Cir.	3		3
IT 320	Hydraulics & Pneumatics	3		3
		13	9	16

SEMESTER 4

Number	Course Title	Class	Lab	Credits
IT 410	Instr./Repair & Trouble Shooting	2	2	3
EB 420	Instrument Project		6	2
NE 100	Economics 1 (or) Elective: Soc. Science	3		3
LE 202	Tech. Report Writing	3		3
ED 420	Microprocessor Theory	3		3
		11	8	14

DIGITAL CONTROL TECHNICIAN (ROBOTICS)

PROGRAM

Digital Control Technician (Robotics)

CONTACT

Goesta Schmidt
Instructor
South Seattle Community College
6000 16th Avenue SW
Seattle, WA 98106
(206) 764-5394

ASSISTANCE AVAILABLE: Yes

SYLLABUS AVAILABLE: Yes

START DATE: 1982

COMPETENCY BASED: Yes

PROGRAM DESCRIPTION

The Digital Control Technology Program is a specialized 2-year training program leading to an associate of applied science degree in digital control technology. Students who successfully complete the program will be prepared for entry-level positions as builders, installers, and repair persons working with a variety of automated systems in which equipment and machines are controlled by microprocessors. Numerically controlled machines and industrial robots are but two of many examples of such equipment. Requirements for the associate of applied science degree are as follows:

Technical Specialty Courses

Number	Course Title	Credits
INT 160	Fundamentals of Electronics	8
INT 161	Amplifiers and Oscillators	8
INT 163	Communication Systems	8
INT 263	Digital Systems	9
INT 265	Microprocessors	10
INT 267	ServoControl Systems and Industrial Robots	10
INT 116-119	Programming for Electronic Technicians	4
		57

Continued

Allied Supporting Classes

Number	Course Title	Credits
MAT 111	Technical Math	4
MAT 112	Technical Math	4
MAT 113	Technical Math	4
PHY 101	General Physics	5
PHY 102	General Physics	5
PHY 103	General Physics	5
		27

General Education Courses

Number	Course Title	Credits
ENG 101	Composition	3
ENG 102	Composition	3
ENG 108	Technical Report Writing	3
	General Education Electives	9
	(one course must be in social science)	18

Total Credits 102

SEMICONDUCTOR TECHNOLOGY TECHNICIAN

PROGRAM

Semiconductor Technology Technician

CONTACT

Ralph Merrill
Department Chairperson and Director
Utah Technical College at Provo-Orem
P.O. Box 1609
Provo, UT 84601
(801) 226-5000, ext. 364

ASSISTANCE AVAILABLE

None

SYLLABUS AVAILABLE

Yes

START DATE

1983

COMPETENCY BASED

Yes

PROGRAM DESCRIPTION

This program is still in a developmental stage. At present the program leads to a 2-year certificate or associate of applied science degree in semiconductor technology. The first year of the program combines the fundamental subjects of electronics, physics, chemistry, mathematics, BASIC language programming, and interpersonal skills. The second year provides specialized instruction to the students in semiconductor technology subjects such as production operations, process theory, electromechanical systems, team skills, and on-the-job training through cooperative education with industry. At present, the instructional aspects of the program are provided by Utah Technical College at Provo and Utah Technical College at Salt Lake with National Semi-Conductor providing the cooperative education aspect.

SOLAR TECHNOLOGY PROGRAM

PROGRAM

Solar Technology Program

CONTACT

Paul L. McQuay
Dean of Applied Sciences
Delaware County Community College
Media, PA 19063
(215) 359-5288

ASSISTANCE AVAILABLE	Yes*	**SYLLABUS AVAILABLE**	Yes
START DATE	1979	**COMPETENCY BASED**	Yes

PROGRAM DESCRIPTION

The Solar Technology Program prepares graduates for employment in the solar energy and construction fields as entry-level technicians. The program includes solar hydronics, heat transfer, energy utilization, sizing, air systems, and installation skills. Experience in the Alternate Energy Laboratory is an integral part of this associate degree program.

***Technical assistance available:**

- Information about the program
- Consultants for proposal preparation, curriculum development, program review, and equipment selection

PROGRAM

Telecommunications

CONTACT

Ray Walsh
Dean Vocational-Technical Education
Jefferson College
P.O. Box 1000
Hillsboro, MO 63050
(314) 789-3951/942-3000

ASSISTANCE AVAILABLE

None

SYLLABUS AVAILABLE

No

START DATE

1983

COMPETENCY BASED

Yes

PROGRAM DESCRIPTION

Jefferson College will be one of the first educational institutions in the Nation to have a complete terminal facility. There are three major types of equipment composing this facility: an FDM Multiplexer, a microwave radio, and a 1000 port Danray Switch.

This program includes both electronic theory and actual hands-on experience in the college's modern telecommunications lab. The curriculum was developed in cooperation with MCI, a leading company in the telecommunications industry.

Appendix B
Curriculum Guidelines and Specifications for a CAD Program

Curriculum Guidelines and Specifications for a CAD Program*

Designing and/or drafting with computer graphics requires a combination of human skills and machine skills. The ability of the machine to do fast calculations, to rotate or change objects on the screen, and to file and duplicate segments of the drawing gives the designer a powerful tool. On the other hand, only the designer can recognize certain undesirable juxtapositions of lines, choose between alternatives, manipulate the data and/or make aesthetic decisions. Thus, the designer's knowledge and intelligence are needed to augment the machine's speed and computing ability.

Much time is saved by computer-aided design, resulting in increased productivity of up to 50 percent for an experienced CAD designer. The designer/drafter is relieved of the necessity of hand-producing many drawings and changes on drawings that can be made quickly by the computer. However, this does not lessen the designer/drafter's need for knowledge of the principles of drawing and design standards and the design processes involved. In fact, the CAD drafter needs a thorough understanding of the theory of orthographic projection, descriptive geometry, and design processes before successful interaction with the equipment can be attained.

The impact of computer-aided design in the industrial environment has created a definite challenge to the educational community--the immediate training of new personnel and the retraining/upgrading of the in-place work force so that they will possess the skills to effectively use this powerful design tool. The challenge is complex, involving equipment selection and the design of an effective educational package. Both of these factors are tied directly to the industrial community to be served and the nature of the educational institution.

Educational Strategy

The integration model chosen--that is, CAD, added to existing courses, separate CAD courses, or a stand-alone CAD program--is the most important single consideration in the introduction of computer-aided design in postsecondary education.

The approach taken, as well as the targeted applications, must drive the selection of equipment--not the reverse. Program areas currently targeted for CAD application include architectural design, machine/mechanical design, electrical technology, commercial art, technical illustration, printing, materials handling, auto body design, and numerical control.

*Excerpted and adapted from *Preparing For High Technology: CAD/CAM Programs* (Abrams et al. 1983, p. 7-18).

Since CAD system architecture is extricably coupled with the design and development of the lessons and courses that make up the CAD curriculum, the CAD system manuals should be strongly considered as a starting point in their design, modified to fit the educational delivery system utilized and the targeted applications.

The Relationship between CAD and CAM

The computerized linking of numerically controlled manufacturing systems to CAD is called CAD/CAM, or computer-aided design/computer-aided manufacturing. The term CAD/CAM implies a fully computerized system of design and manufacture, but it appears to mean different things to different people. Often the term CAD/CAM is applied to a system when the CAM component is either not yet in place or not linked by computer to the CAD components. CAM is commonly viewed as computer control of production machines. The emergence of CAM occurred in the mid-1950s when computers became linked in large numbers with recently introduced numerically controlled machines. However, a full-blown computerized CAD/CAM system, sometimes referred to as CIM (computer-integrated manufacturing), entails very demanding and time-consuming analysis of manufacturing operations, and few companies have achieved this advanced level of technology.

The well-established application of CAD and CAM systems in industry has stimulated the development of courses and programs in these areas of 2-year postsecondary colleges. Although a few postsecondary colleges are investigating the feasibility of a 2 year program for CAD/CAM technicians, it is uncertain at this point whether the volume of classroom material and lab experiences that would have to be absorbed in an effective CAD/CAM program could be mastered within the time available for an associate degree program.

For a more detailed discussion of CAM technology and training considerations for CAM technicians, see appendix C, "Curriculum Guidelines and Specifications for a CAM Program."

CAD Drafting Competencies

This section presents the competencies required to perform entry-level work as a CAD drafter. The list presents background requirements in conventional drafting techniques. These are essential knowledge and skills for entry into drafting and design work and thus can be considered part of the total CAD program.

The CAD student should develop competence in performing various conventional drafting techniques. The drafter should be able to do the following:

- Use drafting instruments
- Use orthographic third angle projection in the construction of engineering drawings
- Project auxiliary views
- Apply measurement systems
- Apply dimensioning systems

- Construct sectional views
- Execute geometric constructions
- Detail threads and fastening devices
- Construct pictorial views
- Identify industrial processes
- Develop surface and plane intersections
- Apply basic concepts of descriptive geometry

Course Outline

The following course outline was developed to be appropriate for any of the CAD "turnkey" systems currently available. It is realized, however, that some "fine tuning" may be necessary to meet specific needs of local industry. In this regard, the course selection has been kept as general as possible within the mechanical and product application area. This area was selected above others (e.g., technical illustration) because it represents currently one of the largest application areas in the manufacturing sector. CAD courses that address specific applications (e.g., fixture design, die design) have not been included and would require additional course development.

Major Course Topics

I. Introduction to CAD
II. System-Hardware Description and Operation
III. System Operating Modes
IV. Drawing File Structure
V. Command Processing
VI. Command Entry Methods
VII. Creation and Manipulation of Drawing Data
VIII. Intersections
IX. Text
X. Dimensioning
XI. Digitizing
XII. Creating Components (Pictorial Library)
XIII. Display Distances, Angles, and Locations
XIV. Three-Dimensional Data Base Concepts
XV. Creating Three-Dimensional Objects
XVI. Cutting Sections
XVII. Projecting Geometry to a Plane

CAD courses beyond this point should be addressed to specific applications (e.g., fixture design, die design).

Course Topic Breakdown--Mechanical and Production Application

I. Introduction to CAD

- A. Man/Machine Interface
- B. CAD--Definition and Applications
- C. System Architecture

II. System Hardware--Description and Operation

- A. Work Station
  - 1. Graphics Display (CRT)
  - 2. Tablet
  - 3. Electronic Stylus (Pen)
  - 4. Alphanumeric Keyboard
  - 5. Function Keyboard
- B. Central Processing Facility
  - 1. Central Processor
  - 2. Disk Subsystem
  - 3. Magnetic Tape Subsystem
- C. Peripheral Equipment
  - 1. Plotter
  - 2. Hardcopy Unit
  - 3. Alphanumeric Terminals

III. System Operating Modes (varies with each system)

- A. Control Mode
- B. Edit Mode
- C. Edit Component Mode
- D. Teach Mode

IV. Drawing File Structure

- A. Dictionary
- B. Library
- C. Drawing Data

V. Command Processing

- A. Syntax
- B. Arguments
- C. Command Execution
- D. Return Key
- E. End of Command

VI. Command Entry Methods

A. Tablet Operations
B. Electronic Pen
C. Function Keyboard
D. Menu
E. Alphanumeric Keyboard

VII. Creation and Manipulation of Drawing Data

A. Logging In (System Entry)
   1. Group, User Concept
   2. Security (Password)
   3. Loading Drawing Files
B. Use of Operating Modes
   1. Storing Drawing Data (Compact Storing)
C. Selecting Geometry
D. Unselecting Geometry
E. Manipulating Geometry
   1. Using Grid System
   2. Moving Geometry
   3. Undrawing Geometry
   4. Deleting Geometry
   5. Changing Shape of Geometry
   6. Rotating Geometry
   7. Copying
   8. Mirroring
   9. Multiple Copies
   10. Adding Lines
      a. Horizontal
      b. Vertical
      c. Diagonal
   11. Adding Arcs
      a. Interior (Less than 180 degrees)
      b. Exterior (More than 180 degrees)
      c. Full Circles
   12. Adding Ellipses
   13. Scaling Geometry
   14. Fillets
   15. Line Types
      a. Solid-Single Weight
      b. Solid-Multiple Weight
      c. Centerlines
      d. Phantom Lines
      e. Hidden (dotted) Lines

VIII. Intersections

A. Lines
B. Lines and Planes
C. Planes and Planes
D. Rules and Surfaces of Revolution

IX. Text

A. Character Set
B. Display of Text
C. Text Selection
D. Adding Text
    1. Text in Free Space
    2. Text at an Added Vertex
    3. Text at a Specific Coordinate
    4. Upper and Lower Case Text
    5. Fractions
E. Editing Text
    1. Deleting from Text String
    2. Inserting into a Text String
    3. Text String Modifications
        a. Changing Font
        b. Changing Text Size
        c. Changing Line Weight
        d. Changing Aspect Ratio
F. Manipulating Text
    1. Fitting Text to Available Space
    2. Moving Text
    3. Copying Text
    4. Rotating Text
G. Alphanumeric Keyboard Characters

X. Dimensioning

A. Standard (Conventional) Dimensioning
    1. Selection Process
    2. Linear Dimension Addition
        a. Horizontal
        b. Vertical Dimensions
        c. Angled Dimensions
    3. Arcs
    4. Circles
    5. Leader Lines
    6. Degree (Angular)
    7. Tolerances
        a. Plus and Minus
        b. High and Low Limit
    8. Dual Dimensioning

B. Baseline Dimensioning
1. Extension Line Only
2. Extension Line and Half-Dimension Line
3. Extension and Dimension Lines
C. Modifying Dimensions
1. Extension Line Trimming
2. Text
3. English to Metric Conversion
D. Geometric Tolerancing
1. Symbols
2. Feature Control Block
3. Basic Dimensional Block

XI. Digitizing

A. Digitizing Devices
1. Small Tablet with Integral-Switch Stylus
2. Large Tablet with Integral-Switch Stylus
3. Large Tablet and Puck with Function Buttons
B. Digitizing Commands and Operation
1. Command Format and Interpretation
2. Aborting Commands and Deleting Arguments
3. Multiple Addition
C. Setting Up for Digitizing
1. Defining a Tablet Area
2. Calibration Commands
D. Adding Components
1. Lines
2. Arcs
3. Cells
E. Three-Dimensional Addition
F. Nonplanar Polyarc or Path Addition
G. Using Menus and Function Buttons

XII. Creating Components (Pictorial Library)

A. Flow Diagram for Creating a Library
B. Component Types
C. Designing a Component Library
D. Cells
1. The Edit Component Mode Drawing Cube
2. Cell Depth
3. Defining a Cell
4. Adding a Cell to a Drawing
5. Defining a New Cell from an Existing Cell
6. Defining a New Cell from Existing Components
7. Aborting Edit Component Mode

XIII. Display Distances, Angles, and Locations

A. Distance between Verticals
B. Coordinate Location in View Cube
C. Location of Identified Points and Vectors
D. Length of Lines
E. Angle Between Lines

XIV. Three-Dimensional Data Base Concepts

A. Fundamental Graphic System Units
B. Natural Units (Inches-mm)
   1. Setting Natural Units
   2. Turning Natural Units Off and On
C. The View Cube
   1. Three-Dimensional Zooming
   2. View Cube Definition
   3. Manipulating the Location and Size of the View Cube
      a. Centering the View Cube
      b. Moving the View Cube
      c. Changing the Size of the View Cube
      d. Viewing the Entire Drawing
D. Saving and Getting Views
E. Controlling the Number and Type of Views
   1. Orthographic Principal Views
   2. Isometric Views
   3. Dimetric Views
   4. Trimetric Views
   5. Single Auxiliary Views
   6. Multiple Auxiliary Views
   7. Rotating the View Cube
   8. Perspective Views
F. Grids
   1. Working Grid
   2. Secondary Grid
   3. Flying Eye Grid (Auxiliary Views)
   4. Angular and Radial Grids
G. Setting Level Status
   1. Edit
   2. Reference
   3. Unedit
H. Using Components on a Level

XV. Creating Three-Dimensional Objects

A. Setting the Deep Plane
B. Bricking of Selected Shapes
C. Creating Edges Between Faces
D. Surfaces of Revolution
E. Ruled Surfaces
F. Warped Surfaces

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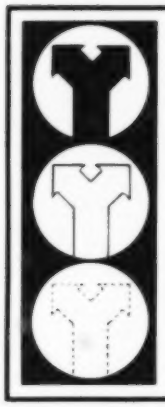
XVI. Cutting Sections

A. Through Plane Faced Objects
B. Through Surfaces of Revolution
C. Through Rules and Warped Surfaces
D. Cross-Hatching

XVII. Projecting Geometry to a Plane

A. Principle Surfaces
B. Inclined Surfaces
C. Oblique Surfaces



Appendix C
Curriculum Guidelines and Specifications for a CAM Program

Curriculum Guidelines and Specifications for A CAM Program*

General Skill Requirements for CAM Users

Specific skill requirements for CAM implementation will be similar to the traditional skills needed for a conventional manufacturing operation. A major difference, however, will be at the organizational level in which the skill is applied and the need at all levels for knowledge about what kind of impact a specific action has on others within the organization. For this reason, every manager or individual contributor should have the ability to analyze the objectives of the company along with how one individual's actions can affect other manufacturing elements. Schools will, therefore, need to expand and enrich microeconomic and financial courses over time. This will demonstrate the impact and sources of cost savings due to CAM and its subelements compared to conventional manufacturing practices and techniques.

A broad CAD/CAM survey course should be required for students seeking degrees in all applicable engineering disciplines. The objective of such a course would be to demonstrate that CAD/CAM technology tends to eliminate isolated functions within a product manufacturing organization and that each of the contributors in the organization adds a special level of expertise to a continuum of information. This infusion of expertise builds progressively from the product concept stage (which may be a solid model image developed and stored within the computer) to the production shop floor where every element of data necessary to produce the designer's concept is available to each specific work station via hardcopy printer or CRT terminal.

The paperless data flow is bidirectional, such that each contributor has the opportunity to provide suggestions and guidance on the feasibility and manufacturability of the product or its components. Thus time and expense are saved in the production process before significant commitment is made toward release of a product that has little chance of meeting manufacturing cost objectives.

This paperless data flow concept should be reinforced during the educational process by use of similar equipment in the schools for classroom exercises, examinations, self-directed study, submission of homework assignments, and theoretical case analysis. This will further enhance the operating skills of the users in training through invaluable hands-on experience.

*Excerpted and adapted from *Preparing for High Technology: CAD/CAM Programs* (Abram et al. 1983, pp. 21-25).

Specific Skill Requirements for CAM Users

The broad functional requirements for a CAM operation include the following elements:

- Programming
- Operations and operations supervision
- Maintenance
- Management
- Planning and analysis

The role of most postsecondary institutions will be in training persons for entry-level work in programming, operations, and maintenance. The following discussion concentrates on programming and operations, but it is important that the student also be provided with a broad business and total system overview.

The skills required by programmers and operations workers are essentially interchangeable. The differences are in the degree to which a particular discipline is applied in day-to-day work. The skills required may best be described by outlining, step-by-step, the *process* of developing a program for a numerical control (NC) machine and by listing under each task the specific skills needed. It must be understood that similar activities are required for programming other computer-controlled shop floor processes.

- Step 1. Analyzes part geometry, materials, finish, and precision required
  - Mathematics, at least geometry and trigonometry
  - Metallurgy
  - Ability to read engineering drawings
- Step 2. Selects machine type(s) and tooling required
  - Knowledge of machine types and capabilities
  - Knowledge of cutting technology
- Step 3. Designs or selects part hold-down fixtures and jigs needed.
  - Fundamental mechanical design, drafting, and documentation
- Step 4. Uses a programming language to define finished part geometry and the geometry of the raw casting, bar stock, or other material from which the part is to be produced
  - Knowledge of computer operating systems
  - Knowledge of the use of the programming language

- Step 5. Defines tool path and chip removal technology (feed rates, spindle speed, and tool selection) for most efficient use of the machine tool and maximum chip removal rate for the tooling available

  - Knowledge of machining processes
  - Knowledge of machines and tooling

- Step 6. Verifies work against graphic representation on hard copy or CRT plotting devices:

  - Knowledge of computer operating system
  - Knowledge of use of specific devices

- Step 7. Edits source program to correct errors or refine the process

  - Knowledge of using system editor

- Step 8. Postprocesses standardized file output to obtain machine image code in either punched tape or direct NC data file format

  - Knowledge of operating system

- Step 9. Tests program on machine tool in "dry run" mode (cuts air or styrofoam)

  - Ability to operate the NC/CNC machine tool

- Step 10. Usually returns to step 7 one or more times depending on part complexity

  - Ability to analyze results of dry run performance using total process knowledge

- Step 11. Machines prototype part on machine tool

  - Ability to operate the NC/CNC machine tool

- Step 12. Tests results in metrology lab using gauging table or other measuring device

  - Understanding of physical material properties
  - Ability to use metrology devices if required

- Step 13. Releases program for production or returns to step 7

  - Good judgment and discipline

This work is performed by highly trained professionals today. Those professionals are now devising methods of extending their capabilities through family-of-part programs such that, in the future, steps 7 through 12 will be performed by entry-level or clerical personnel. Similar disciplines are required for programming and operations supervision of computer-aided plastic injection molding and quality analysis systems. Robotics technology is also moving rapidly toward similar off-line programming techniques.

Training Guidelines

An objective of most CAM product suppliers is to provide systems that are more powerful than traditional manufacturing methods and easier to learn and use. An experienced machinist or machine tool technician can acquire some proficiency in the use of traditional NC programming languages after 40 hours of concentrated training. Full proficiency usually occurs after three to five months of continuous experience.

Both the concentrated training and in-practice training periods are being rapidly reduced through the use of menu selection and immediate response graphics systems. Similar concepts are being developed for computer-aided plastics engineering systems and will undoubtedly be used in other areas, such as robotics programming, process planning, and many other manufacturing engineering-related programs.

For this reason, a broad CAM or CAD/CAM survey course is likely to meet the needs of most students entering this field. This course should be followed up by an in-depth study of the theory behind the user interface. Such a course could cover two to three specific disciplines during a single course term. At least one course in computer science along with the underlying subject theory is a prerequisite.

Training Skills Acquisition

Training skills for CAM technology have in the past been acquired from vendors of the particular product or concept being taught. These vendors can no longer meet the demand for training. However, seminars and user training courses are available periodically from all major suppliers of CAM systems. These courses are almost always included in the purchase price of the system, and most suppliers will offer a free seat to educational institutions, allowing institution faculty to be trained and thus become able to train others.

Equipment and Facilities Needed

Obviously, the equipment and facilities required for instruction in CAM technology are dependent upon the depth of the subject to be covered. A complete CAM system would require access to a large mainframe computer installation. The majority of the manufacturing engineering system technology would, however, operate with multi-user capability on modern minisystems.

Research is required to determine the number of students that can be served per station. From industrial experience and some judgment, three to four students per terminal device would appear adequate for most training situations. Most computer companies will assist in configuring their product installations if rudimentary usage data can be supplied.

Basic Curriculum For CAM Instruction

The following subject areas are essential for a fundamental CAM program in post-secondary institutions:

I. Computer Sciences

A. A conventional overview of the digital computer, its applications, and how it is used
B. Specific training in programming languages, such as COBOL and FORTRAN

II. CAD/CAM Survey

A. Broad definitions and explanations of CAD/CAM functions and how they interrelate
B. Specific instructions in one or more CAM disciplines

III. CAM Economics and Finance

A. Comparisons with traditional manufacturing techniques
B. Specific sources of cost improvements and impact on business

IV. Process Technology

A. Metal and alloys
B. Metal cutting, forming, and fabrication
C. Tooling and fixture design
D. Plastic materials and molding technology
E. Modern shop practices

V. Physical Sciences

A. Physics
B. Chemistry
C. Electronics

VI. Mathematics

A. Geometry and trigonometry
B. Calculus and analytical geometry

Other elective course could cover the following:

- Historical evolution of CAD/CAM technology
- CAD/CAM workshop--interrelating the disciplines in specific case studies

Appendix D
Curriculum Guidelines and Specifications for a Robotics Program

Curriculum Guidelines and Specifications for a Robotics Program*

This section includes general curriculum planning specifications in the form of: (1) a list of technician-level competencies, and (2) sample course descriptions. The competency statements are organized into functional groups and represent a range of duties and responsibilities that a robotics technician might be expected to assume. The course descriptions represent a range of scientific and technical subjects that constitute the core of knowledge and skills required to understand and apply robotics technology. Numbers were assigned to the courses to indicate both a level and a possible sequence of instruction.

Competency statements and course descriptions were prepared by project staff based on material provided by several technical consultants and reviews of course descriptions and training program outlines from both industry and educational institutions.

The materials are intended to serve as general curriculum specifications from which instructors and technical advisors can proceed to select, organize, and develop curriculum materials for specific courses and learning activities.

Robotics Technician Competencies

Technicians must possess a broad range of skills and knowledge in electromechanics that will enable them to access, interpret, understand, and act upon various kinds of technical information presented in various written and graphic forms. The following competencies are related to dealing with technical information and data.

Technicians will Prepare, Read, Interpret and/or Apply--

- Service schedules
- Installation instruction sheets
- Service Orders
- Record forms
- Blueprints

*Excerpted and adapted from *Preparing for High Technology: Robotics Programs* (Ashley et al. 1983, pp. 20-27).

- Block diagrams
- Logic diagrams
- Ladder diagrams
- Power system diagrams
- Computer logic and programming languages
- Programming flow diagrams
- Electric/electronic schematics
- Control flow diagrams
- Technical manuals/documents (technical writing)
- Technical revisions and updates
- Electrical/wiring codes

Technicians must be capable of performing a variety of job tasks required to qualify and maintain the control functions of robots and other automated devices. The following competencies are essential to the performance of programming, adjusting, and trouble-shooting tasks.

Technicians will Install, Program, Adjust, Troubleshoot, and/or Operate--

- Pneumatic logic controllers
- Cam actuated controllers
- Programmable logic controllers
- Digital programmers and controllers
- Electronic sequencers and sensors
- Electronic test equipment such as--

oscilloscopes	ohmeters
counters	voltmeters
ammeters	chart recorders

- Transducers and interface devices
- Microprocessors/electronic circuit boards
- Industrial finishing devices on robots

- Materials handling devices on robots
- Industrial welders on robots
- Encoders and teach modules
- Laser inspection equipment and devices
- Peripheral/host computer communication links

Technicians may be required to perform or direct others in performing a variety of tasks required to maintain the operational efficiency and structural integrity of robot system components and devices. Competencies required to perform such tasks include the following.

Technicians will Remove, Install, Repair, and/or Service--

- Hydraulic pumps, control valves, accumulators, actuators, gauges, lines, filters, cylinders, and servo valves
- Pneumatic pumps, valves, actuators, gauges, lines, and filters
- Electrical power conductors, motors, controllers, switches, and relays
- Electric/electronic drives
- Automatic lubrication systems on robots and transfer line devices
- Mechanical drives and linkages
- Robot end effectors (simple and complex; hydraulic, pneumatic, mechanical, and electrical)
- Transfer line devices and systems

Technicians must function as a responsible member of a business organization and must be able to perform a variety of normal business communications and record-keeping tasks. Competencies required to meet the general business activities that go on in a company include the following.

Technicians will Read, Write, Interpret, Process, and/or File--

- Technical reports and references
- Technical revisions and updates
- Business letters
- Legal contracts (service, warranty, etc.)

- Memos
- Business forms
- Financial forms and reports
- Budget documents
- Charts, graphs, and diagrams
- Estimates of cost, time, and materials
- Travel and expense vouchers
- Policies (company and customer)

Technicians come in contact with a variety of company personnel and customers and must possess effective oral communication skills. Technicians should be competent in both listening and speaking tasks, including the following.

Technicians will Listen To, Interpret, and/or Verbally Present--

- Facts
- Opinions
- Explanations
- Information
- Conclusions
- Policies

Technicians come in contact with a wide range of customer, union, and government policies. Technicians should be aware of the existence of various types of policies and issues which are generally covered by policies. They should be competent in locating, interpreting, applying, or following existing policies in different work situations.

Technicians will Interpret and Apply--

- Customer plant policies
- Safety regulations
- Union policies
- Regulations regarding job skill areas
- Governmental regulations (OSHA)

Suggested Courses in Robotics Technology

The following course titles and descriptions were prepared by project staff with input from many sources and are representative of the courses currently being offered by several postsecondary institutions and industry-based programs to train robotics technicians. The course descriptions are based on specific information obtained during site visits to robot manufacturers, users, and community colleges, and information provided by program developers and faculty currently involved in robot training programs. Algebra, trigonometry, and technical writing skills are also typical requirements.

The arbitrary numbers assigned to each course are intended to suggest both its level and sequence in a 2-year program.

Suggested Courses

- *Fluid Power*

  FP 100 Applied Hydraulics and Pneumatics
  FP 101 Hydraulic and Pneumatic Circuit Analysis

- *Electromechanical*

  EM 110 Basic Electromechanics
  EM 111 Servo Valves and Sensors
  EM 210 Electrical Controls and Automation Circuits
  EM 211 Electromechanical Servicing

- *Electrical/Electronic*

  EE 120 DC and AC Circuit Analysis
  EE 121 Transistor Circuit Theory
  EE 122 Drive Circuits
  EE 220 Digital Logic and Computer Circuits
  EE 221 Computer-Aided Circuit Analysis
  EE 230 Microprocessors-Software
  EE 240 Microprocessors - Hardware
  EE 250 Industrial Control Systems

- *Robotics and Automated Manufacturing*

  RA 130 Introduction to Robots
  RA 131 Machine Tool Processes
  RA 230 Robotic Interfacing
  RA 240 Robotic Applications (Basic)
  RA 241 Robotic Applications (Advanced)
  RA 250 Automated Systems Servicing
  RA 260 Problem Solving/Internship

- *Quality Control Technology*

  QC 150 Metrology (Optional)

Course Descriptions

- *Fluid Power*

  FP 100 Applied Hydraulics and Pneumatics: Principles of hydraulic and pneumatic components and functions of common systems as applied in industrial applications (robots, machine tools, etc.).

  FP 101 Hydraulic and Pneumatic Circuit Analysis: Advanced study of hydraulic and pneumatic circuit applications and control devices with emphasis on system analysis and troubleshooting procedures.

- *Electromechanical*

  EM 110 Basic Electromechanics: Introduction to electromechanical devices, drive trains, and control components; reading and interpreting prints; and operation and repair in robotic and automated equipment/systems.

  EM 111 Servo Valves and Sensors: Investigation of servo valves and sensors; emphasis on operation, maintenance and usage in robotic and automated equipment/systems.

  EM 210 Electrical Controls and Automation Circuits: Advanced study and practice in feedback control systems, control devices, and circuits with emphasis on electrical motor characteristics and operations, programmable logic controllers, bussway interface units, computer-related design assembly, and troubleshooting techniques.

  EM 211 Electromechanical Servicing: Skill development in applying field service practices and test instrumentation to robot controllers, power suppliers, manipulative actuators, transfer line systems, and feedback sensors. Emphasis is placed on troubleshooting and repairing problems in CAD/CAM interface systems and devices for automated manufacturing cells and production equipment.

- *Electrical/Electronic*

  EE 120 DC and AC Circuit Analysis: Principles of basic DC and AC theory utilizing math analysis; emphasis on characteristics of components in basic circuit transformers, power suppliers, etc.

  EE 121 Transitor Circuit Theory: Theory as applied to three common configurations; emphasis on oscillators, amplifiers, and preamplifiers.

EE 122 Drive Circuits: Electronic and transistor theory as applied to electronic drives; emphasis on SCRs, feedback loops, and single and three-phase drive applications.

EE 220 Digital Logic and Computer Circuits: Study of numbering systems (binary, octal, hexadecimal), Boolean algebra, logic circuits (counters, registers, decoders, and storage devices); emphasis on usage in computer circuits.

EE 221 Computer-Aided Circuit Analysis: Study of computer programming utilizing a digital computer in the analysis and design of DC and AC circuits; emphasis on computer languages (BASIC, FORTRAN, etc.).

EE 230 Microprocessors - Software: Theory of applications; emphasis on instruction sets, assembly language, architecture, and programming techniques.

EE 240 Microprocessors - Hardware: Advanced study and practice in working with microprocessors; emphasis on construction, testing, debugging, programming, and design. (Each participant should construct a microprocessor with CPU, I/O, memory, keyboard, and character generator.)

EE 250 Industrial Control Systems: Advanced study and practice in working with the broad spectrum of industrial systems found in a typical industrial environment including electrical energy sources, power distribution systems, industrial control systems, industrial electrical loads, and specification of installation requirements for electrical devices and controls. Emphasis on developing technical knowledge and skills required to install, operate, troubleshoot, and maintain system components and machines according to standard codes and safety regulations.

- *Robotics and Automated Manufacturing*

RA 130 Introduction to Robotics: Introduction to applications in industry; emphasis on types, classifications, types of motion; relationship to NC, CNC, and CAD/CAM; introduction to end effectors.

RA 131 Machine Tool Processes: Introduction to modern machine tool technology with emphasis on the capabilities and applications of automated machine tools including their relationship to CAD/CAM, flexible manufacturing, group technology, and robot operations.

RA 230 Robotic Interfacing: Study of hardware and software necessary for connecting a microprocessor to a robotic arm and interfacing to peripheral machines/equipment; advanced information on end effectors.

RA 240 Robotic Applications (Basic): In-depth study of low- and medium-technology robot concepts, principles, functions, design parameters, and applications with emphasis on developing the technical skills required to specify, install, program, operate, and troubleshoot point-to-point and continuous path robot systems, components, and devices to achieve operational accuracy and reliability in common industrial applications.

RA 241 Robotic Applications (Advanced): Advanced study and training in high-technology robot operations and applications with emphasis on controlled path robots, programmable logic control systems, and production welding systems and operations. Extended practice in off-line programmable set-up, adjustment, and operation of robot welding and materials handling systems to achieve industrial accuracy and reliability standards.

RA 250 Automated Systems Servicing: Instruction in servicing robotic and peripheral automated systems; emphasis on mechanics, hydraulics, and associated electrical/electronics.

RA 260 Problem Solving/Internship: Students are involved in either short-term (2-4 weeks) or longer-term (4-6 weeks) internships in industrial settings and work on actual industry projects. Special problems are brought into the school in conjunction with industrial personnel serving as project team leaders. Experiences provide an opportunity for students to work under actual employment constraints and requirements in preparation for full-time employment.

- *Quality Control Technology (Optional)*

QC 150 Metrology: Introduction and skill development in industrial measurement systems, techniques, instruments and standards including Clean Room procedures; and automatic, pneumatic, and laser gauging and recording instruments. Course will cover basic statistical methods, distribution analysis, process control charts, acceptance sampling, and elements of probability as applied in quality control operations.

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